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(54) **CELLULAR SYSTEM TRAFFIC ALLOCATION AND DYNAMIC LOAD BALANCING**

TELEFONVERKEHRZUTEILUNG UND DYNAMISCHE GLEICHGEWICHTUNG DER LAST IN EINER ZELLULAREN ANORDNUNG

AFFECTATION DU TRAFIC ET EQUILIBRAGE DYNAMIQUE DE LA CHARGE DANS UN SYSTEME CELLULAIRE

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Description

BACKGROUND

1. Technical Field

[0001] This invention relates generally to wireless communication systems; and more particularly to load assignment and dynamic load balancing within a multiple carrier frequency wireless communication system.

2. Related Art

[0002] Cellular wireless communication systems are generally known to include a plurality of base stations dispersed across a geographic service area. Each of the base stations includes at least one antenna and a base station transceiver system (BTS) and provides wireless service within a respective cell. The BTSs couple to base station controllers (BSCs) with each BSC serving a plurality of BTSs. The BSCs also couple to a mobile switching center (MSC) which interfaces to the Public Switched Telephone Network (PSTN) and other MSCs. Together, the BTSs, BSCs and the MSC form a wireless network which provides wireless coverage to mobile units operating within a respective service area.

[0003] Wireless communication systems operate according to various standards. One particular standard in place worldwide is the code division multiple access (CDMA) protocol. Code division multiple access (CDMA) is a direct sequence spread spectrum system in which a number, at least two, of spread-spectrum signals communicate simultaneously, each operating over the same frequency band. In a CDMA system, each user is given a distinct Walsh code which identifies the user. For example, if a first user has a first chip code, $g_1(t)$, and a second user a second chip code, $g_2(t)$, etc., then a receiver located in a BTS, desiring to listen to the first user, receives at its antenna all of the energy sent by all of the users. However, after despreading the first user's signal, the receiver outputs all the energy of the first user but only a small fraction of the energies sent by the second, third, etc., users.

[0004] CDMA is interference limited such that the number of users that can use the same spectrum and still have acceptable performance is determined by the total interference power that all of the users, taken as a whole, generate. Thus, the number of users that may be supported by each BTS is limited. To increase the capacity of CDMA systems, additional base stations may be added to increase the number of cells within the service area. However, because load is often concentrated in a small geographic area, even with the addition of cells, particular cells may remain overloaded while neighbouring cells are lightly loaded.

[0005] Thus, another solution has been proposed to overcome overcrowding in CDMA systems. This solution includes assigning multiple carriers within a single service area with the multiple carriers used to service overlaying cells. With overlaying frequency coverage, some mobile units are serviced on one of the carrier frequencies while other of the mobile units are serviced on other of the carrier frequencies. By assigning multiple frequency resources, the overall capacity of the wireless communication system is increased.

[0006] However, due to the nature of accessing the CDMA system and assigning resources in the CDMA system, one frequency may tend to become loaded at a rate greater than the other frequency. Thus, there is an inherent problem in such wireless communication systems in properly allocating usage amongst the multiple carrier frequencies to maximise carrier traffic for a given blocking probability.

[0007] Thus, there is a need in the art for a system and associated method of operation for allocating load amongst multiple carrier frequencies in a multiple carrier frequency system and in balancing load in the multiple carrier frequency system.

[0008] A system for allocating a mobile unit to a selection of base stations operating on more than one frequency is disclosed in JP 09187055 (Toshiba) and US 6021123 (Toshiba).

SUMMARY OF THE INVENTION

[0009] A wireless communication system constructed according to the present invention overcomes the above cited shortcoming relating to load management in multiple carrier frequency systems as well as additional shortcomings. The wireless communication system provides wireless service to a mobile unit operating within a service area and includes a mobile switching centre, at least one base station controller coupled to the mobile switching centre, a first plurality of base station and a second plurality of base stations. The first plurality of base stations couple to the at least one base station controller and operate on a first carrier frequency. The second plurality of base stations couple to the at least one base station controller and operate on a second carrier frequency. At least one base station controller producing a capacity request in response to a request made by a said mobile unit; at least one candidate base station of the first plurality of base stations receiving said capacity request, determining its net excess capacity based upon available forward link resources and available reverse link resources and responding with a net excess capacity response; at least one candidate base station of the second plurality of base stations receiving said capacity request, determining its net excess capacity based upon available forward link resources and available reverse link resources and responding with a net excess capacity response; the at least one base station controller operating to assign the mobile unit to at least one responding candidate base station of the first plurality of base stations or to at least one responding candidate base station of the second plurality of base stations based upon net excess capacity

responses received by the at least one base station controller. The invention is characterised by means to calculate the net excess capacities for each frequency as a function of: respective forward link blocking threshold levels; respective reverse link blocking threshold levels; respective excess number of channel elements; and respective excess number of Walsh codes; and to assign the mobile unit to at least one of the responding candidate base stations operating on a frequency corresponding to the frequency at which the calculated net excess capacity is the greatest, whereby to achieve dynamic load balancing.

[0010] The wireless communication system may operate according to a code division multiple access protocol. However, in other implementations, the wireless communication system may operate according to other protocols such as a time division multiple access protocol of the Global Standard for Mobility (GSM) protocol, for example.

[0011] In determining the capacity of the base stations, candidate base stations are first determined, with such candidate base stations selected based upon an operating location of the mobile unit. Operation according to the present invention may be undertaken when setting up a call or during the servicing of a call. During servicing of a call, operations commence upon receipt of a pilot signal strength measurement message received from the mobile unit.

[0012] In a typical construction the first plurality of base stations and the second plurality of base stations provide overlaying wireless coverage. In such construction, cells serviced by the second plurality of base stations overlay cells serviced by some of the first plurality of base stations such that the first carrier frequency is supported through the service area and the second carrier frequency is supported in a portion of the service area. Multi-carrier border cells support both the first carrier frequency and the second carrier frequency and border portions of the service area that support only the first carrier frequency or that border neighbouring service areas. Operation in the multi-carrier border cells enable mobile units to roam between areas supported by multiple carrier frequencies and areas supported by a single carrier frequency.

[0013] The invention also encompasses a method of operating a wireless communication system and a computer program element, both adapted to achieve the same effect as the apparatus.

[0014] Of course, the teachings of the present invention may be readily applied to wireless communication systems that support in excess of two carrier frequencies. Further, multi-carrier border cells may lie between separate systems, one which supports multiple carrier frequencies and one which does not. In either case, the multi-carrier border cells provide transition operations for mobile units moving between multi-carrier areas and single carrier areas or between areas supporting differing sets of carriers.

[0015] Calls originating in cells supporting both the first and second carrier frequencies may be originated on either the first carrier frequency or the second carrier frequency. However, calls originating in cells supported by only a single carrier frequency must be originated on the supported carrier frequency. In roaming after call origination, soft handoff may be used when roaming to cells supporting the current carrier frequency. However, hard handoff must be used when roaming to cells not supporting the current carrier frequency. In both cases, operations according to the present invention are undertaken to balance the load between the first carrier frequency and the second carrier frequency.

[0016] Moreover, other aspects of the present invention will become apparent with further reference to the drawings and specification which follow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

FIG. 1 is a diagram illustrating a wireless communication system constructed according to the present invention;

FIG. 2A is a block diagram illustrating various components of the wireless communication system previously introduced in FIG. 1;

FIG. 2B is a block diagram illustrating components of a base station controller constructed according to the present invention;

FIG. 3 is a logic diagram illustrating, in general, operation of the wireless communication system in allocating resources among multiple carrier frequencies in setting up and servicing a call to a mobile unit;

FIG. 4 is a logic diagram illustrating, in general, operation of the wireless communication system in performing dynamic load balancing among a plurality of carrier frequencies within the wireless communication system;

FIG. 5A and 5B are logic diagrams illustrating operation of the wireless communication system in allocating load among multiple carrier frequencies when setting up a call;

FIG. 6A and 6B are logic diagrams illustrating operation of the wireless communication system in dynamically balancing load among multiple carrier frequencies while servicing a call;

FIG. 7 is a diagram illustrating a layout of a wireless communication system having multiple carrier cells, border cells and single frequency cells;

FIG. 8 is a diagram illustrating in more detail cells previously introduced in FIG. 7 at a border region that are sectorized;

FIG. 9 is a message flow diagram corresponding to operation of the wireless communication system in allocating load in a multiple carrier frequency wireless communication system; and

FIG. 10 is a message flow diagram corresponding to operation of the wireless communication system

in performing dynamic load balancing in a multiple carrier frequency wireless communication system.

DETAILED DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1 illustrates a wireless communication system 100 constructed according to the present invention which includes a plurality of cells serviced by multiple carrier frequencies. In the illustrated embodiment, the wireless communication system 100 operates according to a code division multiple access (CDMA) standard, in particular the TIA/EIA/IS95 CDMA standard, modified as required to accomplish the teachings of the present invention. The principles of the present invention also apply to other wireless communication systems operating according to other standards, as well, in which multiple carrier frequencies overlay one another to increase the capacity of the wireless communication system 100.

[0019] The wireless communication system 100 includes a mobile switching center (MSC) 102, base station controllers (BSCs) 104 and 106, and a plurality of base stations, each of which includes an antenna and a base station transceiver subsystem (BTS). The MSC. 102 couples the wireless communication system 100 to the PSTN 116. The wireless communication system services calls between 118 connected to the PSTN 116, for example, and any of a plurality of mobile units 130, 132 and 134 operating within the wireless communication system. The wireless communication system 100 also services calls between the plurality of mobile units 130, 132 and 134.

[0020] BTSs 108A, 108B, 110A and 110B couple to BSC 104 while BTSs 112A, 112B, 114A and 114B couple to BSC 106. The BTSs are constructed such that two carrier frequencies are supported within the wireless communication system. BTS 108A provides service on a first carrier frequency within cell 120A and BTS 108B provides service on a second carrier frequency within cell 120B, cell 120A substantially overlying cell 120B. Likewise, BTS 110A provides wireless coverage on the first carrier frequency in cell 122A and BTS 110B provides wireless coverage on the second carrier frequency in overlying cell 122B. Further, BTSs 112A and 114A provide wireless coverage on the first carrier frequency in cells 124A and 126A, respectively, and BTSs 112B and 114B provide wireless coverage on the second carrier frequency in overlying cells 124B and 126B, respectively. By providing wireless coverage on the two carrier frequencies, the capacity provided by the wireless communication system 100 is approximately double that which would be available with a single carrier frequency. Each of the cells within the wireless communication system 100 may also be divided into sectors as is generally known.

[0021] The wireless communication system 100 was originally constructed to provide coverage on a single carrier frequency and then expanded to support a second carrier frequency due to an increase in load growth within the service area. To support operation on the second carrier frequency, additional towers were added to service BTSs 108B, 110B and 112B. However, BTS 114B is serviced by the same tower as BTS 114A, with an antenna added to the existing tower to support BTS 114B. The principles of the present invention apply equally to wireless communication systems constructed originally to support two or more carrier frequencies.

[0022] In an example of an operation of the wireless communication system 100, mobile unit 130 initiates a call within cell 120A or 120B which is intended for a destination 118 coupled to the PSTN 116. Assuming that the mobile unit 130 responds on a control channel of the first carrier frequency, the mobile unit 130 contacts BTS 108A, seeking to initiate the call. BTS 108A then sends an origination message via the BSC 104 to the MSC 102. The MSC 102 then requests the BSC 104 to allocate resources to service the call and commences to complete the call via the PSTN 116 to destination 118. The BSC 104 then sends capacity requests to each BTS that may service the call within the wireless communication system 100, e.g. BTSs 108A and 108B serving cells 120A and 120B. The BTSs 108A and 108B respond with capacity indications and, based upon the capacity indications, the BSC 104 selects BTS 108B to service the call on the second carrier frequency. The call is then completed via BTS 108B, BSC 104, MSC 102 and the PSTN 116. Of course, in another operation, the BSC 104 could select BTS 108A to service the call on the first carrier based upon differing capacity indications.

[0023] In another operation of the wireless communication system 100 a call originates from telephone 118 and is sought to be delivered to mobile unit 132. When the telephone 118 contacts the MSC 102 via the PSTN 116, the MSC 102 initiates a page to the mobile unit 132 according to paging operations for the wireless communication system 100. The mobile unit 132 then responds to the page via BTS 114A, for example. The BTS 114A responds to the MSC 102 via the BSC 106 and the interacts with BSC 106 to set up the call. In response, the BSC 106 queries BTSs 114A and 114B for capacity information. Based upon the responses received from BTSs 114A and 114B, the BSC 106 assigns a traffic channel on the first carrier frequency, serviced by BTS 114A and corresponding to cell 126A. The call is then completed via BTS 114A, BSC 106, MSC 102 and the PSTN 116. Of course, in another operation based upon differing capacity indications, the BSC 106 could assign a traffic channel on the second carrier frequency serviced by BTS 114A within cell 126B.

[0024] In still another example of operation according to the present invention, a mobile unit 134 has previously established a traffic channel on the first carrier frequency within cell 122A served by BTS 110A. However, the mobile unit 134 is roaming toward cells 124A and 124B served by BTSs 112A and 112B, respectively. While roaming, the mobile unit 134 receives pilot signals provided by BTSs 110A and 112A on the first carrier fre-

quency. When pilot signal strength criterion have been satisfied, the mobile unit 134 sends a pilot signal strength measurement message (PSMM) to BSC 104 via BTS 110A, indicating that it desires to place/keep BTS 112A and BTS 110A in its active set. Prior to directing the handoff, the wireless communication system 100 performs dynamic load balancing to balance loading on the first carrier frequency and the second carrier frequency. In performing dynamic load balancing, the BSCs 104 and 106 query BTSs 110A, 110B and 112A, 112B, respectively to determine loading. Depending upon loading in cells 122A, 122B, 124A and 124B, the wireless communication system 100 either directs the mobile unit 134 to execute a soft handoff on the first carrier frequency to BTSs 110A and 112A or to execute a hard handoff by moving from the first carrier frequency to the second carrier frequency served to BTSs 110B and 112B.

[0025] FIG. 2A illustrates components of wireless communication system 200 constructed according to the present invention. Illustrated are a BSC 202, an MSC 204 coupled to the PSTN 205 and a plurality of BTS sites 206, 208 and 210. BTS site A 206 includes BTS 1 220 which supports a first carrier frequency and BTS 2 222 which supports a second carrier frequency. BTS site B 208 includes BTS 3 224 which supports only the first carrier frequency. BTS site C 210 includes 3 BTSs, BTS 4 226 which supports the first carrier frequency, BTS 5 228 which supports the second carrier frequency and BTS 6 230 which supports a third carrier frequency. In a typical installation, other BTS sites couple to the BSC 202 as well to provide coverage throughout a service area.

[0026] The BSC 202 includes a selector bank subsystem (SBS) 211, a pilot data base (PDB) 216 and a CDMA interconnect system (CIS) 218. The SBS 211 includes a selector bank (SEL) 212 and a SBS controller (SBSC) 214. The SBS 211 as well as the CIS 218 couple to the MSC 204. Further, the CIS 218 couples to the BTSs 220 through 230 contained at the various sites and the SBS 211. The SBS 211 couples to the PDB 216 and controls the SEL 212 to provide communication, in conjunction with the CIS 218, between the MSC 204 and the BTSs 220-230. The SBSC 214 operates to perform multiple carrier frequency allocation and dynamic load balancing according to the present invention to allocate resources in servicing calls on the various carrier frequencies supported by the wireless communication system.

[0027] FIG. 2B illustrates an alternate construction of components of a wireless communication system 250 according to the present invention, with particular description of a BSC 252. The BSC 252 couples to a base station monitor 282, a mobile switching center 284 and BTSs group A 288, group B 288 and group C 290, each of which includes a plurality of BTSs. The BSC 252 includes a base station manager card 268 and an SBSC card 270, both of which couple to the base station manager 282. A selector card 272 and an MSC interface card 274 couple to the MSC 284. BTS interface card 1 276 couples to BTS group A 286, BTS interface card 2 278 couples to BTS group B 288 and BTS interface card 3 280 couples to BTS group C 290. These cards 268 through 280 allow the BSC 252 to perform the operations consistent with the present invention in initially allocating resources and in performing dynamic load balancing in the multiple carrier frequency system.

[0028] The BSC 252 also includes a processor 254, dynamic RAM 256, static RAM 258, EPROM 260, and bulk storage that couple to the cards 268 through 280 via interface 266. Such components perform overall management of the BSC 252. Operations of the present invention are accomplished by these components and the interface cards 268-280 contained in the BSC 252. As is generally known in the art, electronic processing equipment, such as the processor 254 and components of the interface cards 268-280 contained within the BSC 252 may be programmed to perform specific operations. The electronic processing equipment may be constructed specifically to accomplish operations consistent with the present invention or may be generally constructed, and then programmed specifically to perform operations according to the present invention.

[0029] FIG. 3 illustrates operation 300 of a wireless communication system according to the present invention in allocating resources on their respective carrier frequencies upon initiation of a call. Operation commences at optional step 302 where a mobile unit is paged by the wireless communication system. When the mobile unit requests to establish a call, no page is sent to the mobile unit and step 302 is not performed. At step 304, the mobile unit communicates with the wireless communication system, either in response to the page sent at step 302 or when attempting to establish the call. The BTS communicating with the mobile unit then contacts its serving BSC, sending its cell ID to the BSC. The BSC relays this information to the MSC.

[0030] In one embodiment of the present invention, control channels are supported only on one carrier frequency of the multiple carrier frequencies supported across the wireless communication system. In other embodiments, control channels are supported on more than one carrier frequency. Depending upon the embodiment, and the operations supported by the mobile unit, the mobile unit contacts a BTS on a carrier frequency that supports a control channel.

[0031] Next, at step 306, the MSC serving the BSC directs the BSC to allocate resources to service the call. In response, the BSC determines candidate BTSs to service the call and seeks capacity information from each candidate BTSs. At step 308, the BSC receives the excess capacity reports from the candidate BTSs that respond. While it is desired that each candidate BTS respond to indicate its excess capacity, some of the candidate BTSs may not respond. With the reported excess capacity information received, at step 310, the BSC selects at least one BTS from those reporting based upon the reported excess capacities and frequency preferenc-

es for the particular operation. As was previously described, multiple BTSs may serve a common area on differing carrier frequencies. Thus, a particular carrier frequency is resultantly selected at step 310. After the selection is made, operation proceeds to step 312 wherein a traffic channel serviced by the selected BTS(s) on the selected carrier frequency is assigned and the call is serviced until it is complete.

[0032] FIG. 4 illustrates operation 400 according to the present invention in dynamically balancing traffic serviced by the wireless communication system. Operation commences at step 402 wherein the system receives a handoff request from the mobile unit. The handoff request would typically be in the form of a PSMM in which the mobile unit requests to add particular base stations, corresponding to the reported pilot signals, to its active set.

[0033] Next, at step 404, cell IDs are determined from the PSMM for candidate base stations. Further, based upon the serving cell IDs, additional candidate base stations are determined, such additional candidate base stations serving the same area but operating on other carrier frequencies. In determining such candidate base stations, the BSC may access the pilot database 216 that was previously illustrated in FIG. 2A. Once all candidate base stations have been identified, the BSC sends excess capacity requests to each candidate BTS. At step 408, the BSC receives excess capacity reports from the candidate BTSs. The BSC then selects one or more BTSs from those reporting based upon reported excess capacities and frequency preferences at step 410. Then, at step 412, the handoff is executed based upon the selections previously made. The handoff executed at step 412 is a soft handoff if the mobile unit continues to be served on the same carrier frequency. However, if the mobile unit is moved to a different carrier frequency, the handoff is a hard handoff.

[0034] FIG. 5A and 5B illustrate in greater detail allocation of resources of a wireless communication system constructed according to the present invention upon call initiation, with particular applicability to CDMA operation. Referring first to FIG. 5A, operation commences at step 502 wherein a BSC has received a request for radio link resources from an MSC for a specific CDMA cell. Such request is sent by the MSC in attempting to complete a call that was either initiated by a mobile unit or that is to be terminated to a mobile unit. Then, at step 504, the BSC serving the specific CDMA cell sends capacity estimate requests to all BTSs associated with the cell and starts a timer.

[0035] Operation then moves to step 506 wherein the BTS waits for responses to the capacity estimates. If the timer expires at step 508, operation moves to step 516. If all responses have been received at step 510, the timer is stopped at step 514 and operation also moves to step 516. Finally, from step 506 if a response is received, operation moves via off page connector to FIG. 5B. The following definitions and equations may be used in one particular embodiment to determine excess capacity for a particular BTS.

Definitions:

MCTA- Multi-Carrier Traffic Allocation

BSC - Base Station Controller

BTS - BaseStation Transceiver Subsystem

MSC - Mobile Switching Center

EFC - Excess Forward Link Capacity = (Maximum Allowable Forward Link Power - Current Forward Link Power)

$(EFC)_{bt}$ - Excess Forward Link Capacity Blocking Threshold. The call is blocked if EFC falls below $(EFC)_{bt}$.

ERC - Excess Reverse Link Capacity = (Thermal Noise Floor at the Base Station/Total Receive Power at the Base Station)

$(ERC)_{bt}$ - Excess Reverse Link Capacity Blocking Threshold. The call is blocked if ERC falls below $(ERC)_{bt}$.

ECE - Excess Number of Channel Elements.

$(ECE)_{bt}$ - Excess Channel Element Blocking Threshold. The call is blocked if ECE falls below $(ECE)_{bt}$.

EWC - Excess Number of Walsh Codes

$(EWC)_{bt}$ - Excess Walsh Code Blocking Threshold. The call is blocked if EWC falls below $(EWC)_{bt}$.

NEC - Net Excess Capacity. This is the maximum excess capacity of a BTS. It is calculated by taking into account EFC, ERC, $(EFC)_{bt}$, $(ERC)_{bt}$, ECE and EWC as follows:

First, translate ERC and EFC into number of additional radio links possible.

M = Number of current users served by the sector (cell).

N_r = Number of additional links possible before reverse link blocking is encountered = $(N_{pole}(1- (ERC)_{bt}) - M)$ where $N_{pole} = M / (1 - ERC)$

N_f = Number of additional links possible before forward link blocking is encountered = $(EFC - (EFC)_{bt})/P_{avg}$ where P_{avg} is the average power per user.

P_{avg} = (current total traffic channel transmit power/M)

N_c = Number of additional links possible before number of channel elements are exhausted = ECE

N_w = Number of additional links possible before number of walsh codes are exhausted =EWC

[0036] The maximum net excess capacity is limited by the minimum value of N_r , N_f , N_c and N_w. For example even if N_r , N_f and N_w are high but no channel elements are available i.e. $N_c = 0$, the net excess capacity would be zero.

[0037] NEC = min (N_r, N_f, N_c, N_w)

[0038] $(NEC)_t$ - Net Excess Capacity Threshold. This

is the value above which the frequency is considered to be lightly loaded.

According to these equations, each of the BTSs that has been queried may provide its NEC and $(NEC)_t$ to the BSC. In a desired operation, each of the queried BTSs will respond to the BSC with the requested information.

[0039] At step 516 it is determined whether any BTS is considered for allocation. No BTSs will be considered if none responded or if each responding BTS indicates that it has no excess capacity. If no BTS is considered, operation proceeds to step 518 wherein a send radio link resource unavailable response is sent from the BSC to the MSC to indicate that the call cannot be serviced. However, if any BTS has been considered at step 516, operation proceeds to step 520 where it is determined whether any of the BTSs that have responded have an NEC greater than NEC_t. If not, operation proceeds to step 522 wherein the BTS with the highest NEC value is selected. If so, operation proceeds to step 524 wherein the BTS with the highest frequency priority from the set of responding BTSs that have an NEC; that is greater than NEC_{ti}. NEC_{ti} is set by the system operator.

[0040] Referring now to FIG. 5B, from both steps 522 and 524 operation proceeds via off screen connector B to step 538 of FIG. 5B where a send radio link resource available response is sent to the MSC identifying the selected BTS. The call is then completed and serviced by the selected BTS. Operation also proceeded from step 512 of FIG. 5A to step 526 of FIG. 5B when a response is received at step 506. At step 526, it is determined whether the BTS has excess capacity. If the BTS does have excess capacity, operation proceeds to step 528 wherein the NEC is calculated for the particular BTS. However, if the BTS does not have excess capacity it is removed from consideration at step 540 and operation proceeds at step 542 back to step 506 of FIG. 5A. After calculating the NEC for the BTS at step 528, it is determined whether the NEC is greater than the NEC_t at step 530. If the NEC is not greater than the NEC_t, operation proceeds to step 532 wherein the BTS is kept in consideration and the NEC is stored and then to step 542 wherein operation proceeds again to step 506.

[0041] If at step 530 it is determined that the NEC is greater than NEC_t operation proceed to step 534 wherein it is determined whether the BTS frequency has the highest priority. If not, operation proceeds again to step 532. However, if at step 534 it is determined that the BTS frequency has the highest priority, operation proceed to step 536 wherein the BTS is selected and the timer is stopped. From step 536 operation proceeds then to step 538 wherein the radio link resource available response is sent to the MSC identifying the selected BTS.

[0042] In another embodiment of the operation described with respect to FIGs. 5A and 5B, multiple BTSs could be selected. As is known, multiple BTSs often service a single call within CDMA systems. Multiple BTSs could also be selected in the subsequent operation described with reference to FIGs. 6A and 6B in an alternate embodiment.

[0043] FIGs. 6A and 6B illustrate dynamic load balancing operation according to the present invention. Operation 600 commences at step 602 wherein a PSMM is received from a mobile unit. Then, at step 604, based upon the PSMM, the BSC determines resources available for each of the BTSs reported by the mobile unit and each BTS that serves overlaying areas. The system then sends capacity estimate requests to each of these BTSs. Operation proceeds from step 604 to step 606 wherein the wireless communication system waits for responses from the queried BTSs.

[0044] If a response is received at step 612 operation proceeds via off page connector A to step 624 of FIG. 6B wherein the NEC is calculated for the BTS. Once the NEC for the BTS is calculated operation proceeds to step 628 where it is determined whether the NEC is greater than the HBT_1. If so, operation proceeds to step 632 wherein the BTS is kept in consideration and the respective NEC is stored. From step 632 operation proceeds via step 634 back to step 606 of FIG. 6A. However, if at step 626 it is determined that the NEC is not greater than HBT_t for the BTS, the BTS is removed from consideration at step 630. From step 630 operation proceeds then to step 634 which sends operation back to step 606 of FIG. 6A.

[0045] Referring again to FIG. 6A, when all responses have been received at step 610, the timer is stopped at step 614 and operation proceeds to step 616. Further, when the timer is expired at step 608 operation proceeds to step 616. At step 616, all BTSs under consideration are grouped into frequency sets. As is evident, the number of frequency sets will be determined by the number of different carrier frequencies supported by the BTSs that have responded. From step 616, operation proceeds to step 618 wherein frequency sets that provide only partial coverage for the areas under consideration are removed. Then, at step 620 it is determined whether any frequency set is under consideration. If no frequency sets are under consideration at step 620, operation proceeds to step 622 wherein a soft handoff denied response is sent to the mobile unit. However, if any frequency is under consideration at step 620 operation proceed through off page connector B to step 636 at FIG. 6B.

[0046] At step 636 of FIG. 6B, the NEC_f value is calculated for each frequency set. Then, at step 638, the frequency set with the highest NEC_f is selected. At step 640 a radio link resource request is sent to each BTS in the selected frequency set which directs the BTSs to operate, such selected BTSs corresponding to the carrier frequency selected. Such continued operation may execute a soft handoff on the previously selected carrier frequency or may cause the mobile unit to perform a hard handoff to a different carrier frequency.

[0047] FIG. 7 illustrates a plurality of cells in a wireless communication system 700 constructed according to the present invention. As is shown, the wireless communication system 700 includes a plurality of multiple carrier

frequency cells (M), a plurality of border cells (B) and a plurality of single carrier frequency cells (S). In the installation illustrated, the multiple carrier frequency cells support two or more carrier frequencies while the single frequency cells support only a single carrier frequency. A typical installation of such a system 700 may be in a densely populated downtown area such as the greater Dallas area wherein multiple carrier frequency cells are placed in areas where load density exceeds the capacity that could be served by a single carrier frequency cell. In geographic areas of high density of use, the multiple carrier cells are installed to increase the capacity of those particular cells. However, in the outlying areas, the single frequency cells provide sufficient capacity to service the needs of the users that operate within those cells.

[0048] Zone 1 is defined by line 704 to include the multiple carrier cells while zone 2 is defined by line 702 to include only the single frequency cells, such single frequency cells lying outside of circle 702. The area between circles 702 and 704 defines the border zones for the system 700. Mobile units originating calls within zone 2 outside of circle 702 must always originate on carrier F1 and are allocated resources only on frequency F1. Mobile units originating calls within zone 1 may originate a call on either carrier F1 or carrier F2 (the two carriers supported within zone 1) with resources allocated on frequency F1 or frequency F2. Finally, mobile units originating calls within the border zone between circles 702 and 704 must always originate calls on carrier F 1 and are allocated resources on frequency F1.

[0049] Once a call has been set up with a mobile unit and is being serviced within the wireless communication system 700, as the mobile unit roams, operations must occur that consider the limitations of the multiple carrier frequency cells M, the border cells B and the single frequency cells S. Mobile units roaming within zone 2 and being served by single frequency cells S, are handed off from cell to cell using soft handoff on frequency F1. Mobiles roaming within zone 1 and being served by multiple carrier frequency cells M also are handed off from cell to cell on their current carrier frequency using soft handoff, their current carrier frequency being either frequency F1 or frequency F2.

[0050] Mobiles crossing boundaries from zone 2 to zone 1 stay on carrier frequency F1 and therefore also are handed off between cells using soft handoff. However, mobile units crossing the boundaries from zone 1 to zone 2 that were allocated resources on frequency F2 are handed off using hard handoff to frequency F1 at the border cells. Finally, mobile units operating on frequency F 1 crossing boundaries between zone I and zone 2 in either direction are handed off using soft handoff and remain on frequency F1. Mobile units to which service is originated while operating in the border cells may be allocated resources on either frequency F1 or frequency F2 depending upon whether the border cells operate according to the principles previously described with respect to resource allocation.

[0051] FIG. 8 illustrates a border region 800 of a wireless communication system, such as the border region residing generally located near circles 702 and 704 of FIG. 7. The border region 800 includes multiple carrier frequency cells that include overlying cells 802A and 802B operating on a first carrier frequency F1 and a second carrier frequency F2, respectively. Single carrier frequency cell 806 operates on the first carrier frequency F1 and adjoins a border 814. On the border, cell 804A operates on the first carrier frequency F and cell 804B operates on the second carrier frequency F2, cell 804A overlaying cell 804B. As is shown, cells 804A and 804B each include sectors i, j and k. The border 814 is defined as the area in which sector k of both cells 804A and 804B overlay cell 806.

[0052] Also shown in FIG. 8 is a mobile unit 810 that may reside at positions 1, 2, and 3 during its operation. When the mobile unit 810 originates a call at position (3), it is allocated resources on carrier frequency F1 served by cell 806 since only carrier frequency F1 is supported within cell 806. Then, when the mobile unit 810 moves from position (3) to position (2) within sector k of border cell 804A, soft handoff is performed from cell 806 to cell 804A sector k. Then, when the mobile unit 810 moves from position (2) to position (1), soft handoff is performed from cell 804A sector k to cell 804A sector j and from 804A sector j to cell 802A.

[0053] When the mobile unit 810 originates a call at position (1), it may be allocated resources on either carrier frequency F 1 or F2 and be served by 802A or 802B, respectively. With the mobile unit 810 moving from position (1) to position (2) to position (3) on frequency F1, soft handoff is performed from cell 802A to cell 804A sector j, to cell 804A sector k and then to cell 806 on carrier frequency F1 On the other hand, if the mobile unit originates a call at position (1) on carrier frequency F2 in cell 802B then soft hand will be performed from cell 802B to cell 804B sector j and to cell 804B sector k on carrier frequency F2. However, hard handoff is then performed from cell 804A sector k on carrier frequency F1 to cell 804B sector k on carrier frequency F2. Once the hard handoff has been performed, soft handoff will then be performed from cell 804B sector k to cell 806 on frequency F2. When the mobile unit 810 originates a call at position (2), the mobile unit 810 will be allocated resources on frequency F1 within sector k of cell 804A. Operation will then proceed accordingly assuming the originating carrier frequency F1.

[0054] Paging of mobile units within the various cells may be accomplished on either one or both of the carrier frequencies F1 and F2. Typically, operation is consistent within a single system, such operation using either multiple frequency carriers or a single carrier frequency for control channels. However, when the border 814 is between systems, two different scenarios may occur. In a first scenario, one system uses multiple carrier frequencies for the control channel while the other system uses a single carrier frequency for the control channel. In the

second scenario, both systems use multiple carrier frequencies for the control channel. Thus, the mobile units and systems must interact so as to prevent dropped calls when a mobile unit moves from one system to the other. Operation between systems must be coordinated by the system operators.

[0055] FIG. 9 illustrates the messages that pass among the components of a wireless communication system in originating and servicing a call according to the present invention. At time 902 a mobile unit sends an origination message to a BTS servicing its immediate geographic area. The origination message may be in response to a page or may be initiated in response to a request made by the user of the mobile unit. At time 904, the BTS sends an originate message to the MSC via a BSC coupled to the BTS, the BSC including an SBS and an SBSC. The originate message includes the mobile unit identifier and the cell ID for the BTS. At time 906 the MSC sends a message to the SBS in the BSC, requesting a selector entity to service the call. At time 908, the SBS responds to the MSC, sending the ID of a selector which has been allocated to service the call. At time 910 the MSC then sends a set up link message to the SBS which includes the cell number and mobile number.

[0056] The SBS then sends a cell address message to the SBSC, identifying a particular cell from which the mobile unit sent its origination request. In response, at time 914, the SBSC sends out capacity requests to each BTS that may provide service to the mobile unit. Then, at time 916 the BTSs respond to the SBSC with capacity responses. The SBSC then determines which BTS(s) will provide service to the mobile unit based upon the principles of the present invention. In selecting the BTS(s) to provide service, the SBSC investigates the capacity of the responding BTSs consistent with operations described with reference to FIGs. 5A and 5B.

[0057] Then, at time 920, the SBS provides a set up link message to the BTS(s), requesting the BTS(s) to service the call to the mobile unit. At time 922, the BTS (s) sends a connect message to the mobile unit requesting that the mobile unit communicate with the BTS(s). Then, at time 924, the call is serviced by the wireless communication system with such servicing continued until the call has either been terminated by the mobile unit or by the wireless communication system.

[0058] FIG. 10 illustrates the exchange of messages performed in allocating traffic in a multiple carrier frequency system. At time 1002, the mobile unit sends a PSMM to the BSC via its serving BTS. The PSMM for example includes the identity of BTS 0 and BTS 3. The BSC receives the PSMM, determines the identity of BTS 0 and BTS 0 and three and determines which BTSs are candidates BTSs. The BSC determines that BTSs 0, 1 and 2 are candidate BTSs and sends capacity requests at times 1004, 1006, and 1008 to BTS 2, BTS 1, and BTS 0, respectively. At times 1008, 1010, and 1012, BTS 2, BTS 1 and BTS 0 send capacity response messages to the BSC. Based on the information contained in the capacity request, the BSC selects the particular BTSs that will service the mobile unit and to which handoff of the mobile unit will be executed. At time 1014, the BSC responds to the mobile unit with and extended handoff direction message (EHDM) directing the mobile unit to add BTS 1 and BTS 2 to its active set. The EHDM may simply cause the mobile unit to execute a soft handoff should the mobile unit remain on the same carrier frequency. However, should BTS 1 and BTS 2 provide service on a differing carrier frequency than that currently serving mobile unit, the EHDM message will be used to execute a hard handoff for the mobile unit to a differing carrier frequency.

[0059] In view of the above detailed description of the present invention and associated drawings, other modifications and variations will now become apparent to those skilled in the art. It should also be apparent that such other modifications and variations may be effected without departing from the scope of the present invention as set forth in the claims which follow.

Claims

1. A wireless communication system that provides wireless service to a mobile unit (130) operating within a service area (120), the wireless communication system comprising:

   a mobile switching centre (102);
   at least one base station controller (104) coupled to the mobile switching centre;
   a first plurality of base stations (108A, 110A) coupled to the at least one base station controller (104), the first plurality of base stations operating on a first carrier frequency;
   a second plurality of base stations (108B, 110B) coupled to the at least one base station controller (104), the second plurality of base stations operating on a second carrier frequency;
   said at least one base station controller (104) producing a capacity request in response to a request made by a said mobile unit;
   at least one candidate base station of the first plurality of base stations adapted to receive said capacity request, determine its net excess capacity (NEC) based upon available forward link resources and available reverse link resources and respond with a net excess capacity response;
   at least one candidate base station of the second plurality of base stations adapted to receive said capacity request, determine its net excess capacity (NEC) based upon available forward link resources and available reverse link resources and respond with a net excess capacity response;
   said at least one base station controller (104)

adapted to assign the mobile unit to at least one responding candidate base station of the first plurality of base stations (108A. 110A) or to at least one responding candidate base station of the second plurality of base stations (108B, 110B) based upon net excess capacity responses received by the at least one base station controller;

characterised by means to calculate said net excess capacities for each frequency as a function of:

respective forward link blocking threshold levels;
respective reverse link blocking threshold levels;
respective excess number of channel elements; and
respective excess number of Walsh codes;

and to assign the mobile unit to at least one of the responding candidate base stations operating on a frequency corresponding to the frequency at which the calculated net excess capacity is the greatest, whereby to achieve dynamic load balancing.

2. The wireless communication system of claim 1, wherein said at least one base station controller (104) is adapted to assign the mobile unit to at least one of the first plurality of base stations or at least one of the second plurality of base stations upon setting up a call or during servicing of a call.

3. The wireless communication system of claim 1 or claim 2, wherein the first plurality of base stations (108A, 110A) and the second plurality of base stations (108B. 110B) are adapted to provide overlaying wireless coverage.

4. The wireless communication system of any of the preceding claims, wherein the first plurality of base stations (108A, 110A) and the second plurality of base stations (108B, 110B) are adapted to operate according to a code division multiplex access protocol.

5. The wireless communication system as claimed in any of the preceding claims, wherein the request received from the mobile unit (130) is in the form of a pilot strength measurement message.

6. The wireless communication system as claimed in any of the preceding claims, wherein cells served by the second plurality of base stations (108B, 110B) overlay cells serviced by some of the first plurality of base stations (108A. 110A) such that the first carrier frequency is supported throughout the service area and the second carrier frequency is supported in a portion of the service area.

7. The wireless communication system as claimed in any of the preceding claims, wherein the first plurality of base stations (108A, 110A) and the second plurality of base stations (108B. 1108) support border cells (B) that define the portion of the service area supported by both the first carrier frequency and the second carrier frequency.

8. The wireless communication system as claimed in claim 7, wherein the border cells (B) support both the first carrier frequency and the second carrier frequency.

9. The wireless communication system as claimed in claim 7 or claim 8, wherein calls originating in border cells (B) only originate on the first carrier frequency.

10. A method of operating a wireless communication system that provides wireless service to a mobile unit (130) operating within a service area (120), the wireless communication system comprising:

a mobile switching centre (102);
at least one base station controller (104) coupled to the mobile switching centre;
a first plurality of base stations (108A, 110A) coupled to the at least one base station controller (104), the first plurality of base stations operating on a first carrier frequency;
a second plurality of base stations (108B, 110B) coupled to the at least one base station controller (104), the second plurality of base stations operating on a second carrier frequency;
the method comprising:

receiving at a said base station controller a request from said mobile unit (130) within a service area (120) covered by one of said first or second plurality of base stations;
determining an operational position of the mobile unit within the service area;
based upon the operational position of the mobile unit (130), requesting capacity information from candidate base stations of the first plurality of base stations (108A, 110A) and candidate base stations from said second plurality of base stations (1088, 110B);
receiving at a said base station controller (104) net excess capacity responses from the candidate base stations, each net excess capacity response based upon available forward link resources and available reverse link resources of a respective candidate base station;
selecting at least one servicing base station from the candidate base stations based up-

on the received net excess capacity responses, the at least one servicing base station corresponding to either the first carrier frequency or the second carrier frequency; and

servicing the mobile unit (130) with the at least one servicing base station on a corresponding carrier frequency;

the method **characterised by**:

calculating said net excess capacities for each frequency as a function of:

respective forward link blocking threshold levels;

respective reverse link blocking threshold levels;

respective excess number of channel elements; and

respective excess number of Walsh codes;

and assigning the mobile unit (130) to at least one of the responding candidate base stations operating on a frequency corresponding to the frequency at which the calculated net excess capacity is the greatest, whereby to achieve dynamic load balancing.

11. The method of claim 10, wherein the first plurality of base stations and the second plurality of base stations provide overlaying wireless coverage.

12. The method of claim 10 or claim 11, wherein the first plurality of base stations and the second plurality of base stations operate according to a code division multiplex access protocol.

13. The method of any of claims 10 to 12, wherein the request received from the mobile unit (130) is in the form of a pilot strength measurement message.

14. The method of any of claims 10 to 13, wherein cells served by the second plurality of base stations overlay cells serviced by some of the first plurality of base stations (108A, 110A) such that the first carrier frequency is supported throughout the service area and the second carrier frequency is supported in a portion of the service area.

15. The method of any of claims 10 to 14, wherein the first plurality of base stations (108A, 110A) and the second plurality of base stations (108A, 1108) support border cells (B) that define the portion of the service area supported by both the first carrier frequency and the second carrier frequency.

16. The method of daim 15, wherein the border cells (B) support both the first carrier frequency and the second carrier frequency.

17. The method of claims 15 or 16, wherein calls originating in border cells only originate on the first carrier frequency.

18. A computer program element having computer program code means that is readable by at least one component of a wireless communication system that provides service to a mobile unit (130) in a service area (120) and that includes a first plurality of base stations (108A, 110A) coupled to at least one base station controller (104), the first plurality of base stations operating on a first carrier frequency, and a second plurality of base stations (108B, 110B) coupled to the at least one base station controller (104) and operating on a second carrier frequency, the first and second carrier frequencies supporting communication with said mobile unit (130); the computer program code means arranged when running on said at least one component to make the wireless communication system execute a procedure to:

cause the wireless communication system to receive a request from said mobile unit (130);

cause the wireless communication system to determine an operational position of the mobile unit (130) within said service area (120);

cause the wireless communication system to request capacity information from candidate base stations of the first plurality of base stations (108A, 110A) and candidate base stations of the second plurality of base stations (110B, 110B);

cause the wireless communication system to receive net excess capacity responses from the candidate base stations, each net excess capacity response based upon available forward link resources and available reverse link resources for a respective candidate base station;

cause the wireless communication system to select at least one servicing base station from the candidate base stations based upon the received net excess capacity responses, the at least one servicing base station corresponding to either the first carrier frequency or the second carrier frequency; and

cause the wireless communication system to service the mobile (130) unit with the at least one servicing base station on a corresponding carrier frequency;

characterised in that the computer program code means is further arranged when running on said at least one component to make the wireless communication system execute procedure to:

cause said net excess capacities to be calculat-

ed for each frequency as a function of:

respective forward link blocking threshold levels;
respective reverse link blocking threshold levels;
respective excess number of channel elements; and
respective excess number of Walsh codes;

and to cause the mobile unit (130) to be assigned to at least one of the responding candidate base stations operating on a frequency corresponding to the frequency at which the calculated net excess capacity is the greatest, whereby to achieve dynamic load balancing.

19. The computer program element of claim 18, wherein the first plurality of base stations (108A, 110A) and the second plurality of base stations (108B, 110B) provide overlaying wireless coverage.

20. The computer program element of claim 18 or claim 19, wherein the first plurality of base stations (108A, 110A) and the second plurality of base stations (108B, 110B) operate according to a code division multiplex access protocol.

21. The computer program element of any of claims 18 to 20, wherein the request received from the mobile unit (130) is in the form of a pilot strength measurement message.

22. The computer program element of any of claims 18 to 21. wherein cells served by the second plurality of base stations (108B, 110B) overlay cells serviced by some of the first plurality of base stations (108A. 110A) such that the first carrier frequency is supported throughout the service area and the second carrier frequency is supported in a portion of the service area.

23. The computer program element of any of claims 18 to 22, wherein the first plurality of base stations (108A, 110A) and the second plurality of base stations (108B, 110B) support border cells (B) that define the portion of the service area supported by both the first carrier frequency and the second carrier frequency.

24. The computer program element of claim 23, wherein the border cells (B) support both the first carrier frequency and the second carrier frequency.

25. The computer program element of any of claims 18 to 23, wherein the computer program code means is further arranged when running on said at least one component to make the wireless communication system execute a procedure to cause the wireless communication system to originate calls in border cells (B) only on the first carrier frequency.

26. A computer readable medium on which is stored the computer program element according to any of claims 18 to 25.

Patentansprüche

1. Drahtloses Kommunikationssystem, das einen drahtlosen Dienst für eine mobile Einheit (130) bereitstellt, die in einem Versorgungsbereich (120) arbeitet, wobei das drahtlose Kommunikationssystem Folgendes umfasst:

eine Funkvermittlungsstelle (102);
zumindest eine Basisstationssteuerung (104), die mit der Funkvermittlungsstelle gekoppelt ist;
eine erste Vielzahl von Basisstationen (108A, 110A), die mit zumindest einer Basisstationssteuerung (104) gekoppelt sind, wobei die erste Vielzahl von Basisstationen auf einer ersten Trägerfrequenz arbeitet;
eine zweite Vielzahl von Basisstationen (108B, 110B), die mit der zumindest einen Basisstationssteuerung (104) gekoppelt sind, wobei die zweite Vielzahl von Basisstationen auf einer zweiten Trägerfrequenz arbeitet;

wobei die zumindest eine Basisstationssteuerung (104) eine Kapazitätsanforderung als Antwort auf eine von der mobilen Einheit gemachte Anforderung erzeugt;
wobei zumindest eine Kandidaten-Basisstation der ersten Vielzahl von Basisstationen so ausgebildet ist, dass sie die Kapazitätsanforderung empfängt, ihre Netto-Überschusskapazität (NEC) auf der Grundlage der verfügbaren Vorwärtsstrecken-Ressourcen und der verfügbaren Rückwärtsstrekken-Ressourcen bestimmt und mit einer Netto-Überschusskapazitäts-Antwort antwortet;
wobei zumindest eine Kandidaten-Basisstation der zweiten Vielzahl von Basisstationen so ausgebildet ist, dass sie die Kapazitätsanforderung empfängt, ihre Netto-Überschusskapazität (NEC) auf der Grundlage der verfügbaren Vorwärtsstrecken-Ressourcen und der verfügbaren Rückwärtsstrekken-Ressourcen bestimmt und mit einer Netto-Überschusskapazitäts-Antwort antwortet;
wobei die zumindest eine Basisstationssteuerung (104) so ausgebildet ist, dass sie die mobile Einheit zu zumindest einer antwortenden Kandidaten-Basisstation der ersten Vielzahl von Basisstationen (108A, 110A) oder zu zumindest einer antwortenden Kandidaten-Basisstation der zweiten Vielzahl von Basisstationen (108B, 110B) auf der Grundlage der

Netto-Überschusskapazitäts-Antworten zuordnet, die von der zumindest einen Basisstationssteuerung empfangen werden;
gekennzeichnet durch Einrichtungen zur Berechnung der Netto-Überschusskapazitäten für jede Frequenz als eine Funktion von Folgendem:

jeweilige Vorwärtsstrecken-Blockierungs-Schwellenwertpegel;
jeweilige Rückwärtsstrecken-Blockierungs-Schwellenwertpegel;
jeweilige überschüssige Anzahl von Kanalelementen; und
jeweilige überschüssige Zahl von Walsh-Codes;

und zur Zuordnung der mobilen Einheit zu zumindest einer der antwortenden Kandidaten-Basisstationen, die auf einer Frequenz arbeitet, die der Frequenz entspricht, bei der die berechnete Netto-Überschusskapazität am größten ist, um auf diese Weise einen dynamischen Lastausgleich zu erzielen.

2. Drahtloses Kommunikationssystem nach Anspruch 1, bei dem die zumindest eine Basisstationssteuerung (104) so ausgebildet ist, dass sie die mobile Einheit zu zumindest einer der ersten Vielzahl von Basisstationen oder zu zumindest einer der zweiten Vielzahl von Basisstationen beim Aufbau einer Verbindung oder während der Diensteversorgung einer Verbindung zuordnet.

3. Drahtloses Kommunikationssystem nach Anspruch 1 oder 2, bei dem die erste Vielzahl von Basisstationen (108A, 110A) und die zweite Vielzahl von Basisstationen (108B, 110B) so ausgebildet sind, dass sie eine überlappende Funkversorgung bereitstellen.

4. Drahtloses Kommunikationssystem nach einem der vorhergehenden Ansprüche, bei dem die erste Vielzahl von Basisstationen (108A, 110A) und die zweite Vielzahl von Basisstationen (108B, 110B) so ausgebildet sind, dass sie gemäß einem Codemultiplex-Vielfachzugriffs-Protokoll arbeiten.

5. Drahtloses Kommunikationssystem nach einem der vorhergehenden Ansprüche, bei dem die von der mobilen Einheit (130) empfangene Anforderung die Form einer Pilotsignalstärken-Messmitteilung hat.

6. Drahtloses Kommunikationssystem nach einem der vorhergehenden Ansprüche, bei dem Zellen, die von der zweiten Vielzahl von Basisstationen (108B, 110B) mit Diensten versorgt werden, Zellen überlappen, die von einigen der ersten Vielzahl von Basisstationen (108A, 110A) mit Diensten versorgt werden, derart, dass die erste Trägerfrequenz über den gesamten Versorgungsbereich unterstützt ist und die zweite Trägerfrequenz in einem Teil des Versorgungsbereiches unterstützt ist.

7. Drahtloses Kommunikationssystem nach einem der vorhergehenden Ansprüche, bei dem die erste Vielzahl von Basisstationen (108A, 110A) und die zweite Vielzahl von Basisstationen (108B, 110B) Randzellen (B) unterstützt, die den Teil des Versorgungsbereiches definieren, der sowohl von der ersten Trägerfrequenz als auch von der zweiten Trägerfrequenz unterstützt ist.

8. Drahtloses Kommunikationssystem nach Anspruch 7, bei dem die Randzellen (B) sowohl die erste Trägerfrequenz als auch die zweite Trägerfrequenz unterstützen.

9. Drahtloses Kommunikationssystem nach Anspruch 7 oder 8, bei dem von Randzellen (B) ausgehende Verbindungen lediglich auf der ersten Trägerfrequenz ausgehen.

10. Verfahren zum Betrieb eines drahtlosen Kommunikationssystems, das einen drahtlosen Dienst an eine mobile Einheit (130) liefert, die in einem Versorgungsbereich (120) arbeitet, wobei das drahtlose Kommunikationssystem Folgendes umfasst:

eine Funkvermittlungsstelle (102);
zumindest eine Basisstationssteuerung (104), die mit der Funkvermittlungsstelle gekoppelt ist;
eine erste Vielzahl von Basisstationen (108A, 110A), die mit der zumindest einen Basisstationssteuerung (104) gekoppelt ist, wobei die erste Vielzahl von Basisstationen auf einer ersten Trägerfrequenz arbeitet;
eine zweite Vielzahl von Basisstationen (108B, 110B), die mit der zumindest einen Basisstationssteuerung (104) gekoppelt ist, wobei die zweite Vielzahl von Basisstationen auf einer zweiten Trägerfrequenz arbeitet;

wobei das Verfahren Folgendes umfasst:

Empfangen, an der Basisstationssteuerung, einer Anforderung von einer mobilen Einheit (130) innerhalb eines Versorgungsbereiches (120), der durch eine der ersten und zweiten Vielzahlen von Basisstationen abgedeckt ist;
Bestimmen einer Betriebsposition der mobilen Einheit innerhalb des Versorgungsbereiches;
auf der Grundlage der Betriebsposition der mobilen Einheit (130), Anfordern von Kapazitätsinformation von Kandidaten-Basisstationen der ersten Vielzahl von Basisstationen (108A, 110A) und von Kandidaten-Basisstationen der zweiten Vielzahl von Basisstationen (108B,

110B);

Empfangen, an der Basisstationssteuerung (104), von Netto-Überschusskapazitäts-Antworten von den Kandidaten-Basisstationen, wobei jede Netto-Überschusskapazitäts-Antwort auf den verfügbaren Vorwärtsstrecken-Ressourcen und den verfügbaren Rückwärtsstrekken-Ressourcen einer jeweiligen Kandidaten-Basisstation beruht;

Auswahl von zumindest einer Dienste liefernden Basisstation aus den Kandidaten-Basisstationen auf der Grundlage der empfangenen Netto-Überschusskapazitäts-Antworten, wobei die zumindest eine Dienste liefernde Basisstation entweder der ersten Trägerfrequenz oder der zweiten Trägerfrequenz entspricht; und

Versorgung der mobilen Einheit (130) mit Diensten von der zumindest einen Dienste bereitstellenden Basisstation auf einer entsprechenden Trägerfrequenz;

wobei das Verfahren durch Folgendes **gekennzeichnet** ist:

Berechnen der Netto-Überschusskapazitäten für jede Frequenz als eine Funktion von Folgendem:

jeweilige Vorwärtsstrecken-Blockierungs-Schwetlenwertpegel;

jeweilige Rückwärtsstrecken-Blockierungs-Schwellenwertpegel;

jeweilige überschüssige Anzahl von Kanalelementen; und

jeweilige überschüssige Anzahl von Walsh-Codes;

und Zuordnen der mobilen Einheit (130) zu zumindest einer der antwortenden Kandidaten-Basisstationen, die auf einer Frequenz arbeiten, die der Frequenz entspricht, bei der die berechnete Netto-Überschusskapazität am größten ist, um auf diese Weise einen dynamischen Lastausgleich zu erzielen.

11. Verfahren nach Anspruch 10, bei dem die erste Vielzahl von Basisstationen und die zweite Vielzahl von Basisstationen eine überlappende drahtlose Überdeckung ergeben.

12. Verfahren nach Anspruch 10 oder 11, bei dem die erste Vielzahl von Basisstationen und die zweite Vielzahl von Basisstationen nach einem Codemultiplex-Vielfachzugriff-Protokoll arbeiten.

13. Verfahren nach einem der Ansprüche 10 bis 12, bei dem die von der mobilen Einheit (130) empfangene Anforderung die Form einer Pilotsignalstärken-Messmitteilung hat.

14. Verfahren nach einem der Ansprüche 10 bis 13, bei dem von der zweiten Vielzahl von Basisstationen mit Diensten versorgten Zellen Zellen überlappen, die von einigen der ersten Vielzahl von Basisstationen (108A, 110A) mit Diensten versorgt werden, derart, dass die erste Trägerfrequenz über den gesamten Versorgungsbereich unterstützt ist und die zweite Trägerfrequenz in einem Teil des Versorgungsbereiches unterstützt wird.

15. Verfahren nach einem der Ansprüche 10 bis 14, bei dem die erste Vielzahl von Basisstationen (108A, 110A) und die zweite Vielzahl von Basisstationen (108B, 110B) Randzellen (B) unterstützt, die den Teil des Versorgungsbereiches definieren, der von sowohl der ersten Trägerfrequenz als auch der zweiten Trägerfrequenz unterstützt ist.

16. Verfahren nach Anspruch 15, bei dem die Randzellen (B) sowohl die erste Trägerfrequenz als auch die zweite Trägerfrequenz unterstützen.

17. Verfahren nach Anspruch 15 oder 16, bei dem Anrufe, die von Randzellen ausgehen, lediglich auf der ersten Trägerfrequenz ausgehen.

18. Computer-Programmelement mit einer Computer-Programmcode-Einrichtung, die von zumindest einer Komponente eines drahtlosen Kommunikationssystems lesbar ist, das Dienste an eine mobile Einheit (130) in einem Versorgungsbereich (120) liefert und das eine erste Vielzahl von Basisstationen (108A, 110A), die mit zumindest einer Basisstationssteuerung (104) gekoppelt sind, wobei die erste Vielzahl von Basisstationen auf einer ersten Trägerfrequenz arbeitet, und eine zweite Vielzahl von Basisstationen (108B, 110B) einschließt, die mit der zumindest einen Basisstationssteuerung (104) gekoppelt sind und auf einer zweiten Trägerfrequenz arbeiten, wobei die ersten und zweiten Trägerfrequenzen eine Kommunikation mit der mobilen Einheit (130) unterstützen, wobei die Computer-Programmcode-Einrichtungen so ausgebildet sind, dass, wenn sie auf der zumindest einen Komponente ablaufen, bewirken, dass das drahtlose Kommunikationssystem ein Verfahren ausführt, um:

zu bewirken, dass das drahtlose Kommunikationssystem eine Anforderung von der mobilen Einheit (130) empfängt;

zu berwirken, dass das drahtlose Kommunikationssystem eine Betriebsposition der mobilen Einheit (130) innerhalb des Versorgungsbereiches (120) bestimmt;

zu bewirken, dass das drahtlose Kommunikationssystem Kapazitätsinformation von Kandidaten-Basisstationen der ersten Vielzahl von Basisstationen (108A, 110A) und von Kandida-

ten-Basisstationen der zweiten Vielzahl von Basisstationen (108B, 110B) anfordert;
zu bewirken, dass das drahtlose Kommunikationssystem Netto-Überschusskapazitäts-Antworten von den Kandidaten-Basisstationen empfängt, wobei jede Netto-Überschusskapazitäts-Antwort auf den verfügbaren Vorwärtsstrecken-Ressourcen und den verfügbaren Rückwärtsstrecken-Ressourcen einer jeweiligen Kandidaten-Basisstation beruht;
zu bewirken, dass das drahtlose Kommunikationssystem zumindest eine Dienste liefernden Basisstation aus den Kandidaten-Basisstationen auf der Grundlage der empfangenen Netto-Überschusskapazitäts-Antworten auswählt, wobei die zumindest eine Dienste liefernde Basisstation entweder der ersten Trägerfrequenz oder der zweiten Trägerfrequenz entspricht; und
zu bewirken, dass das drahtlose Kommunikationssystem die mobile Einheit (130) mit Diensten von der zumindest einen Dienste bereitstellenden Basisstation auf einer entsprechenden Trägerfrequenz versorgt;

dadurch gekennzeichnet, dass die Computer-Programmcode-Einrichtungen so angeordnet sind, dass sie beim Ablauf auf der zumindest einen Komponente bewirken, dass das drahtlose Kommunikationssystem ein Verfahren ausführt, um :

die Berechnung der Netto-Überschusskapazitäten für jede Frequenz als eine Funktion von Folgendem zu bewirken:

jeweilige Vorwärtsstrecken-Blockierungs-Schwellenwertpegel;
jeweilige Rückwärtsstrecken-Blockierungs-Schwellenwertpegel;
jeweilige überschüssige Anzahl von Kanalelementen; und
jeweilige überschüssige Anzahl von Walsh-Codes;

und zu bewirken, dass die mobile Einheit (130) zu zumindest einer der antwortenden Kandidaten-Basisstationen zugeordnet wird, die auf einer Frequenz arbeiten, die der Frequenz entspricht, bei der die berechnete Netto-Überschusskapazität am größten ist, um auf diese Weise einen dynamischen Lastausgleich zu erzielen.

19. Computer-Programmelement nach Anspruch 18, bei dem die erste Vielzahl von Basisstationen (108A, 110A) und die zweite Vielzahl von Basisstationen (108B, 110B) eine überlappende Funkversorgung bereitstellen.

20. Computer-Programmelement nach Anspruch 18 oder 19, bei dem die erste Vielzahl von Basisstationen (108A, 110A) und die zweite Vielzahl von Basisstationen (108B, 110B) gemäß einem Codemultiplex-Vielfachzugriffs-Protokoll arbeiten.

21. Computer-Programmelement nach einem der Ansprüche 18 bis 20, bei dem die von der mobilen Einheit (130) empfangene Anforderung die Form einer Pilotsignalstärken-Messmitteilung hat.

22. Computer-Programmelement nach einem der Ansprüche 18 bis 21, bei dem Zellen, die von der zweiten Vielzahl von Basisstationen (108B, 110B) mit Diensten versorgt werden, Zellen überlappen, die von einigen der ersten Vielzahl von Basisstationen (108A, 110A) mit Diensten versorgt werden, derart, dass die erste Trägerfrequenz über den gesamten Versorgungsbereich unterstützt ist und die zweite Trägerfrequenz in einem Teil des Versorgungsbereiches unterstützt ist.

23. Computer-Programmelement nach einem der Ansprüche 18 bis 22, bei dem die erste Vielzahl von Basisstationen (108A, 110A) und die zweite Vielzahl von Basisstationen (108B, 110B) Randzellen (B) unterstützt, die den Teil des Versorgungsbereiches definieren, der sowohl von der ersten Trägerfrequenz als auch von der zweiten Trägerfrequenz unterstützt ist.

24. Computer-Programmelement nach Anspruch 23, bei dem die Randzellen (B) sowohl die erste Trägerfrequenz als auch die zweite Trägerfrequenz unterstützen.

25. Computer-Programmelement nach einem der Ansprüche 18 bis 23, bei dem die Computer-Programmcode-Einrichtungen weiterhin so angeordnet sind, dass sie beim Ablauf auf der zumindest einen Komponente bewirken, dass das drahtlose Kommunikationssystem ein Verfahren ausführt, um zu bewirken, dass das drahtlose Kommunikationssystem von Randzellen (B) ausgehende Verbindungen lediglich auf der ersten Trägerfrequenz ausgehen lässt.

26. Computer-lesbares Medium, auf dem das Computer-Programmelement nach einem der Ansprüche 18 bis 25 gespeichert ist.

Revendications

1. Système de communication sans fil qui fournit un service sans fil à une unité mobile (130) fonctionnant à l'intérieur d'une zone de service (120), le système de communication sans fil comprenant :

un centre de commutation mobile (102) ;
au moins un contrôleur de station de base (104) couplé au centre de commutation mobile ;
une première pluralité de stations de base (108A, 110A) couplée au au moins un contrôleur de station de base (104), la première pluralité de stations de base fonctionnant sur une première fréquence porteuse ;
une seconde pluralité de stations de base (108B, 110B) couplée au au moins un contrôleur de station de base (104), la seconde pluralité de stations de base fonctionnant sur une seconde fréquence porteuse ;
ledit au moins un contrôleur de station de base (104) produisant une demande de capacité en réponse à une demande effectuée par une dite unité mobile ;
au moins une station de base candidate de la première pluralité de stations de base adaptée pour recevoir ladite demande de capacité, déterminer sa capacité excédentaire nette (NEC) sur la base des ressources de liaison aller disponibles et des ressources de liaison retour disponibles et répondre par une réponse de capacité excédentaire nette ;
au moins une station de base candidate de la seconde pluralité de stations de base adaptée pour recevoir ladite demande de capacité, déterminer sa capacité excédentaire nette (NEC) sur la base des ressources de liaison aller disponibles et des ressources de liaison retour disponibles et répondre par une réponse de capacité excédentaire nette ;
ledit au moins un contrôleur de station de base (104) adapté pour affecter l'unité mobile à au moins une station de base candidate répondant de la première pluralité de stations de base (108A, 110A) ou à au moins une station de base candidate répondant de la seconde pluralité de stations de base (108B, 110B) sur la base des réponses de capacité excédentaire nette reçues par le au moins un contrôleur de station de base ;

caractérisé par un moyen pour calculer lesdites capacités excédentaires nettes pour chaque fréquence en fonction :

des niveaux de seuil de blocage de liaison aller respectifs ;
des niveaux de seuil de blocage de liaison retour respectifs ;
d'un nombre excédentaire respectif d'éléments de canal ; et
d'un nombre excédentaire respectif de codes de Walsh ;
et pour affecter l'unité mobile à au moins une des stations de base candidates répondant fonctionnant sur une fréquence correspondant à la fréquence à laquelle la capacité excédentaire nette calculée est la plus grande, moyennant quoi réaliser un équilibrage de charge dynamique.

2. Système de communication sans fil selon la revendication 1, dans lequel ledit au moins un contrôleur de station de base (104) est adapté pour affecter l'unité mobile à au moins une de la première pluralité de stations de base ou au moins une de la seconde pluralité de stations de base lors de l'établissement d'un appel ou durant la desserte d'un appel.

3. Système de communication sans fil selon la revendication 1 ou la revendication 2, dans lequel la première pluralité de stations de base (108A, 110A) et la seconde pluralité de stations de base (108B, 110B) sont adaptées pour fournir une couverture sans fil de recouvrement.

4. Système de communication sans fil selon l'une quelconque des revendications précédentes, dans lequel la première pluralité de stations de base (108A, 110A) et la seconde pluralité de stations de base (108B, 110B) sont adaptées pour fonctionner selon un protocole d'accès multiplex par répartition en code.

5. Système de communication sans fil selon l'une quelconque des revendications précédentes, dans lequel la demande reçue de l'unité mobile (130) est sous la forme d'un message de mesure d'intensité de pilote.

6. Système de communication sans fil selon l'une quelconque des revendications précédentes, dans lequel les cellules desservies par la seconde pluralité de stations de base (108B, 110B) recouvrent les cellules desservies par certaines de la première pluralité de stations de base (108A, 110A) de sorte que la première fréquence porteuse soit supportée partout dans la zone de service et que la seconde fréquence porteuse soit supportée dans une partie de la zone de service.

7. Système de communication sans fil selon l'une quelconque des revendications précédentes, dans lequel la première pluralité de stations de base (108A, 110A) et la seconde pluralité de stations de base (108B, 110B) supportent des cellules de frontière (B) qui définissent la partie de la zone de service supportée par à la fois la première fréquence porteuse et la seconde fréquence porteuse.

8. Système de communication sans fil selon la revendication 7, dans lequel les cellules de frontière (B) supportent à la fois la première fréquence porteuse

et la seconde fréquence porteuse.

9. Système de communication sans fil selon la revendication 7 ou la revendication 8, dans lequel les appels ayant pour origine les cellules de frontière (B) émettent seulement sur la première fréquence porteuse.

10. Procédé d'exploitation d'un système de communication sans fil qui fournit un service sans fil à une unité mobile (130) fonctionnant à l'intérieur d'une zone de service (120), le système de communication sans fil comprenant :

un centre de commutation mobile (102) ;
au moins un contrôleur de station de base (104) couplé au centre de commutation mobile ;
une première pluralité de stations de base (108A, 110A) couplée au au moins un contrôleur de station de base (104), la première pluralité de stations de base fonctionnant sur une première fréquence porteuse ;
une seconde pluralité de stations de base (108B, 110B) couplée au au moins un contrôleur de station de base (104), la seconde pluralité de stations de base fonctionnant sur une seconde fréquence porteuse ;

le procédé comprenant :

la réception au niveau d'un dit contrôleur de station de base d'une demande provenant de ladite unité mobile (130) à l'intérieur d'une zone de service (120) couverte par une de ladite première ou seconde pluralité de stations de base ;
la détermination d'une position opérationnelle de l'unité mobile à l'intérieur de la zone de service ;
sur la base de la position opérationnelle de l'unité mobile (130), la demande d'une information de capacité de stations de base candidates de la première pluralité de stations de base (108A, 110A) et de stations de base candidates de ladite seconde pluralité de stations de base (108B, 110B) ;
la réception au niveau d'un dit contrôleur de station de base (104) de réponses de capacité excédentaire nette (NEC) des stations de base candidates, chaque réponse de capacité excédentaire nette étant basée sur des ressources de liaison aller disponibles et des ressources de liaison retour disponibles d'une station de base candidate respective ;
la sélection d'au moins une station de base de desserte parmi les stations de base candidates sur la base des réponses de capacité excédentaire nette reçues, la au moins une station de base de desserte correspondant à soit la première fréquence porteuse soit la seconde fréquence porteuse ; et
la desserte de l'unité mobile (130) avec la au moins une station de base de desserte sur une fréquence porteuse correspondante ;
le procédé étant **caractérisé par** :

le calcul desdites capacités excédentaires nettes pour chaque fréquence en fonction :

des niveaux de seuil de blocage de liaison aller respectifs ;
des niveaux de seuil de blocage de liaison retour respectifs ;
d'un nombre excédentaire respectif d'éléments de canal ; et
d'un nombre excédentaire respectif de codes de Walsh ;
et l'affectation de l'unité mobile (130)à au moins une des stations de base candidates répondant fonctionnant sur une fréquence correspondant à la fréquence à laquelle la capacité excédentaire nette calculée est la plus grande, moyennant quoi réaliser un équilibrage de charge dynamique.

11. Procédé selon la revendication 10, dans lequel la première pluralité de stations de base et la seconde pluralité de stations de base fournissent une couverture sans fil de recouvrement.

12. Procédé selon la revendication 10 ou la revendication 11, dans lequel la première pluralité de stations de base et la seconde pluralité de stations de base fonctionnent selon un protocole d'accès multiplex par répartition en code.

13. Procédé selon l'une quelconque des revendications 10 à 12, dans lequel la demande reçue de l'unité mobile (130) est sous la forme d'un message de mesure d'intensité de pilote.

14. Procédé selon l'une quelconque des revendications 10 à 13, dans lequel les cellules desservies par la seconde pluralité de stations de base recouvrent les cellules desservies par certaines de la première pluralité de stations de base (108A, 110A) de sorte que la première fréquence porteuse soit supportée partout dans la zone de service et que la seconde fréquence porteuse soit supportée dans une partie de la zone de service.

15. Procédé selon l'une quelconque des revendications 10 à 14, dans lequel la première pluralité de stations de base (108A, 110A) et la seconde pluralité de stations de base (108B, 110B) supportent des cellules de frontière (B) qui définissent la partie de la zone

de service supportée par à la fois la première fréquence porteuse et la seconde fréquence porteuse.

16. Procédé selon la revendication 15, dans lequel les cellules de frontière (B) supportent à la fois la première fréquence porteuse et la seconde fréquence porteuse.

17. Procédé selon la revendication 15 ou 16, dans lequel les appels ayant pour origine les cellules de frontière émettent seulement sur la première fréquence porteuse.

18. Elément de programme informatique ayant un moyen de code de programme informatique qui est lisible par au moins un composant d'un système de communication sans fil qui fournit un service à une unité mobile (130) dans une zone de service (120) et qui comprend une première pluralité de stations de base (108A, 110A) couplée à au moins un contrôleur de station de base (104), la première pluralité de stations de base fonctionnant sur une première fréquence porteuse, et une seconde pluralité de stations de base (108B, 110B) couplée au au moins un contrôleur de station de base (104) et fonctionnant sur une seconde fréquence porteuse, les première et seconde fréquences porteuses supportant la communication avec ladite unité mobile (130) ; le moyen de code de programme informatique étant disposé lorsque exécuté sur ledit au moins un composant pour faire que le système de communication sans fil exécute une procédure pour :

faire que le système de communication sans fil reçoive une demande provenant de ladite unité mobile (130) ;
faire que le système de communication sans fil détermine une position opérationnelle de l'unité mobile (130) à l'intérieur de ladite zone de service (120) ;
faire que le système de communication sans fil demande une information de capacité de stations de base candidates de la première pluralité de stations de base (108A, 110A) et de stations de base candidates de la seconde pluralité de stations de base (108B, 110B) ;
faire que le système de communication sans fil reçoive des réponses de capacité excédentaire nette (NEC) des stations de base candidates, chaque réponse de capacité excédentaire nette étant basée sur des ressources de liaison aller disponibles et des ressources de liaison retour disponibles pour une station de base candidate respective ;
faire que le système de communication sans fil sélectionne au moins une station de base de desserte parmi les stations de base candidates sur la base des réponses de capacité excédentaire nette reçues, la au moins une station de base de desserte correspondant à soit la première fréquence porteuse soit la seconde fréquence porteuse ; et
faire que le système de communication sans fil desserve l'unité mobile (130) avec la au moins une station de base de desserte sur une fréquence porteuse correspondante ;

caractérisé en ce que le moyen de code de programme informatique est en outre disposé lorsque exécuté sur ledit au moins un composant pour faire que le système de communication sans fil exécute une procédure pour :

faire que lesdites capacités excédentaires nettes soient calculées pour chaque fréquence en fonction :

des niveaux de seuil de blocage de liaison aller respectifs ;
des niveaux de seuil de blocage de liaison retour respectifs ;
d'un nombre excédentaire respectif d'éléments de canal ; et
d'un nombre excédentaire respectif de codes de Walsh ;
et faire que l'unité mobile (130) soit affectée à au moins une des stations de base candidates répondant fonctionnant sur une fréquence correspondant à la fréquence à laquelle la capacité excédentaire nette calculée est la plus grande, moyennant quoi réaliser un équilibrage de charge dynamique.

19. Elément de programme informatique selon la revendication 18, dans lequel la première pluralité de stations de base (108A, 110A) et la seconde pluralité de stations de base (108B, 110B) fournissent une couverture sans fil de recouvrement.

20. Elément de programme informatique selon la revendication 18 ou la revendication 19, dans lequel la première pluralité de stations de base (108A, 110A) et la seconde pluralité de stations de base (108B, 110B) fonctionnent selon un protocole d'accès multiplex par répartition en code.

21. Elément de programme informatique selon l'une quelconque des revendications 18 à 20, dans lequel la demande reçue de l'unité mobile (130) est sous la forme d'un message de mesure d'intensité de pilote.

22. Elément de programme informatique selon l'une quelconque des revendications 18 à 21, dans lequel les cellules desservies par la seconde pluralité de stations de base (108B, 110B) recouvrent les cellu-

les desservies par certaines de la première pluralité de stations de base (108A, 110A) de sorte que la première fréquence porteuse soit supportée partout dans la zone de service et que la seconde fréquence porteuse soit supportée dans une partie de la zone de service.

23. Elément de programme informatique selon l'une quelconque des revendications 18 à 22, dans lequel la première pluralité de stations de base (108A, 110A) et la seconde pluralité de stations de base (108B, 110B) supportent des cellules de frontière (B) qui définissent la partie de la zone de service supportée par à la fois la première fréquence porteuse et la seconde fréquence porteuse.

24. Elément de programme informatique selon la revendication 23, dans lequel les cellules de frontière (B) supportent à la fois la première fréquence porteuse et la seconde fréquence porteuse.

25. Elément de programme informatique selon l'une quelconque des revendications 18 à 23, dans lequel le moyen de code de programme informatique est en outre disposé lorsque exécuté sur ledit au moins un composant pour faire que le système de communication sans fil exécute une procédure pour faire que le système de communication sans fil émettent des appels dans les cellules de frontière (B) seulement sur la première fréquence porteuse.

26. Support lisible par ordinateur sur lequel est stocké l'élément de programme informatique selon l'une quelconque des revendications 18 à 25.

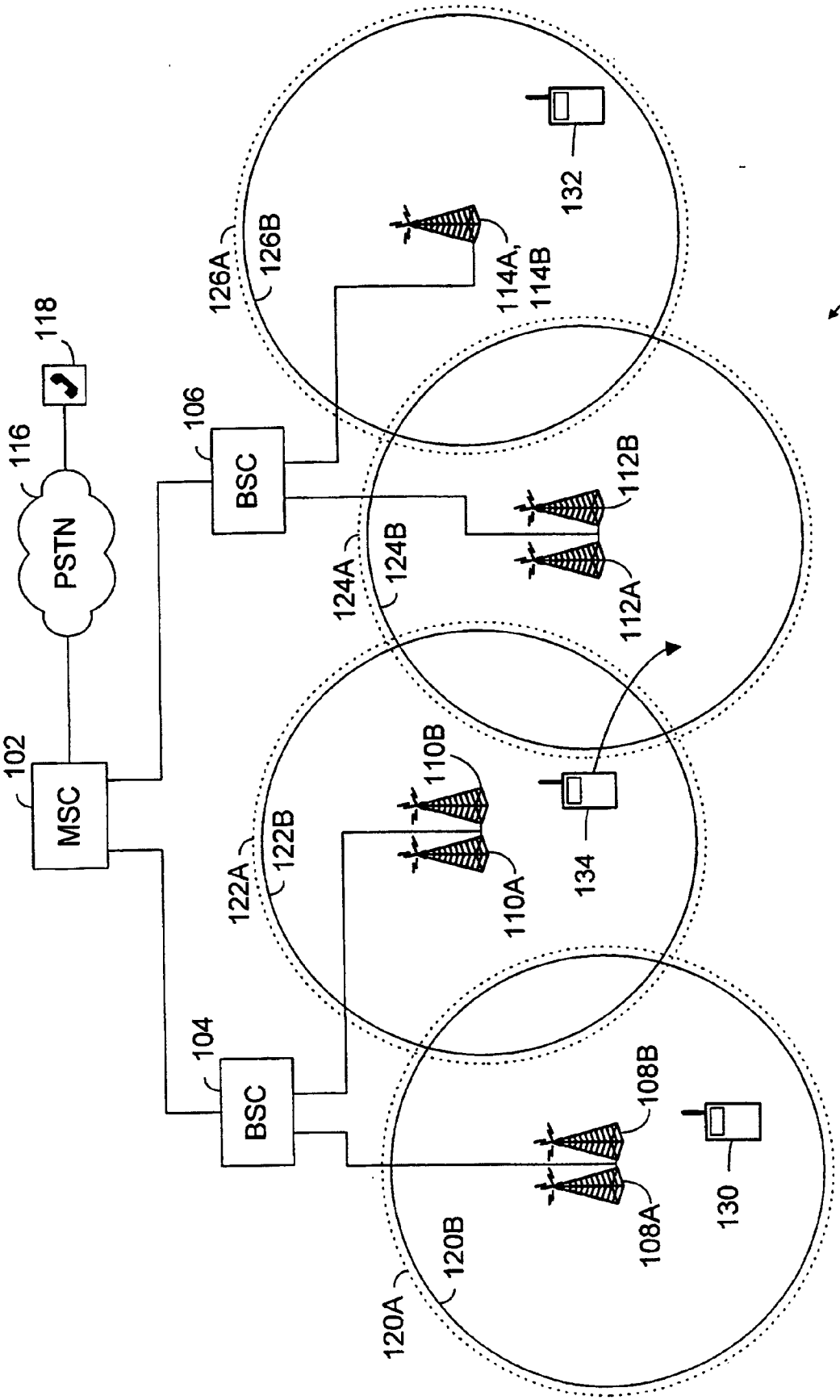
100
MSC
102
PSTN
116
118
BSC
104
BSC
106
120A
120B
108A
108B
130
122A
122B
110A
110B
134
124A
124B
112A
112B
126A
126B
114A
114B
132

FIG. 1

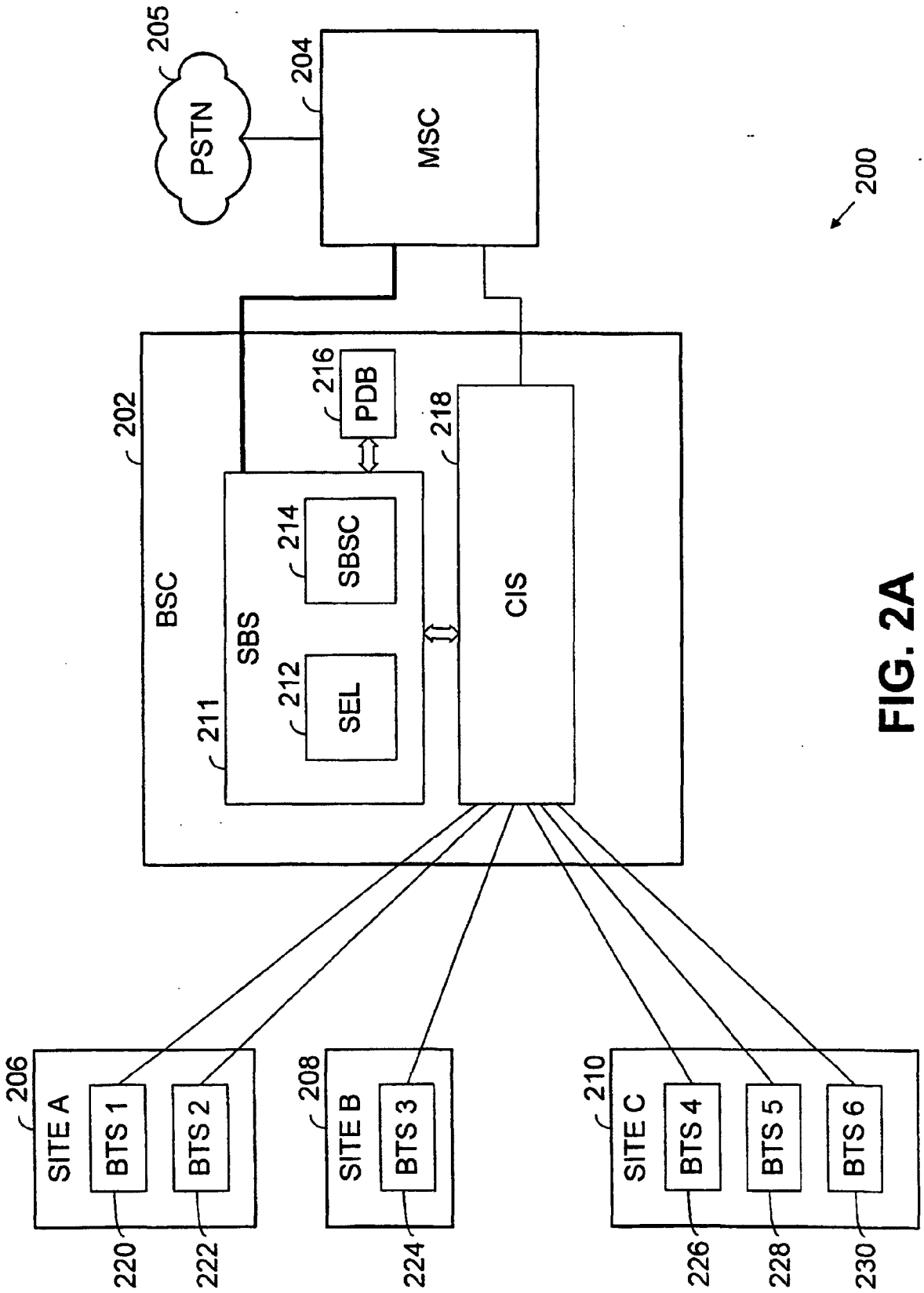
205
PSTN
204
MSC
200
202
BSC
216
PDB
218
214
SBSC
SBS
CIS
212
SEL
211
206
SITE A
BTS 1
BTS 2
208
SITE B
BTS 3
210
SITE C
BTS 4
BTS 5
BTS 6
220
222
224
226
228
230

FIG. 2A

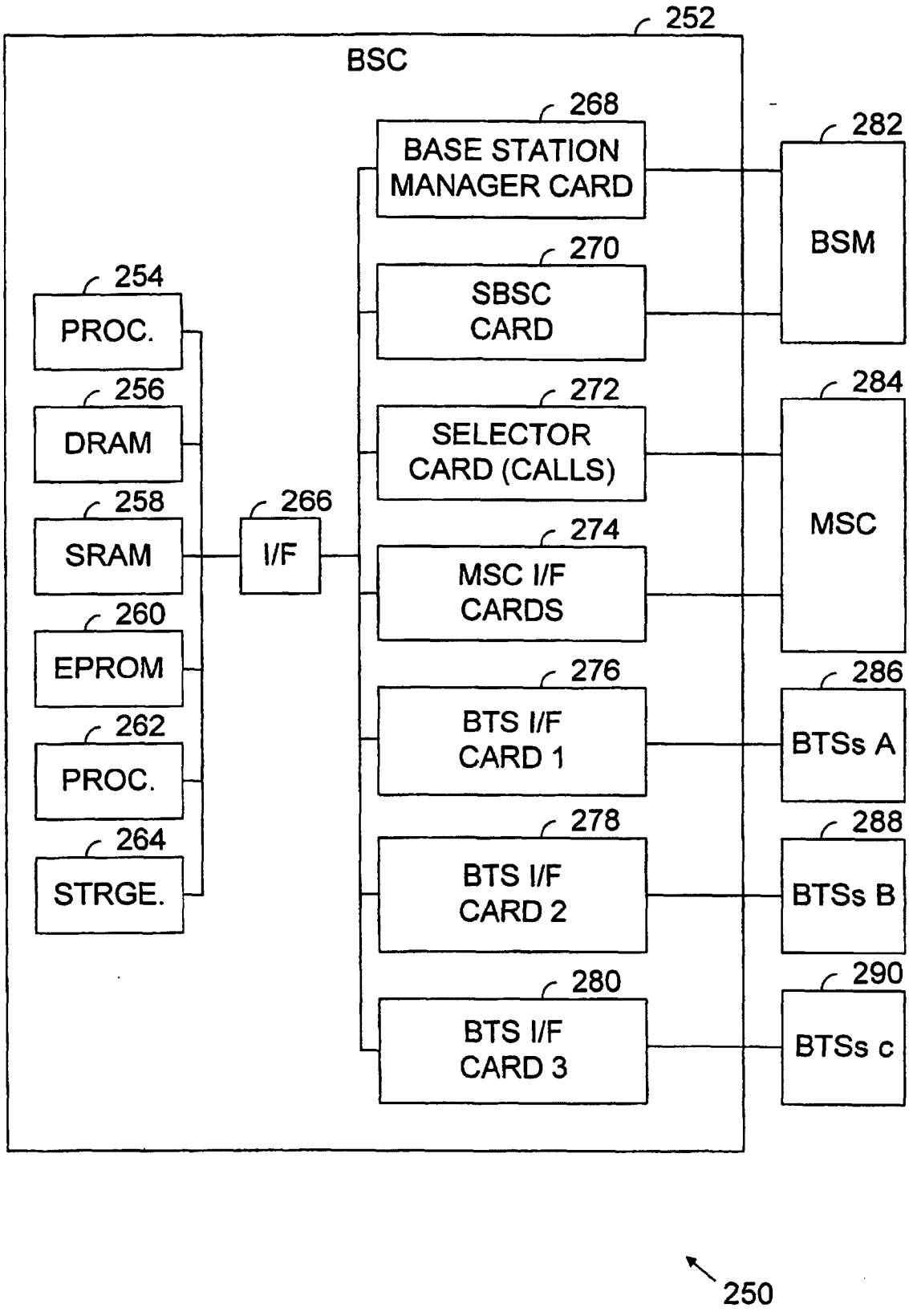
252
BSC
268
BASE STATION MANAGER CARD
270
SBSC CARD
272
SELECTOR CARD (CALLS)
274
MSC I/F CARDS
276
BTS I/F CARD 1
278
BTS I/F CARD 2
280
BTS I/F CARD 3
254
PROC.
256
DRAM
258
SRAM
260
EPROM
262
PROC.
264
STRGE.
266
I/F
282
BSM
284
MSC
286
BTSs A
288
BTSs B
290
BTSs c
250

FIG. 2B

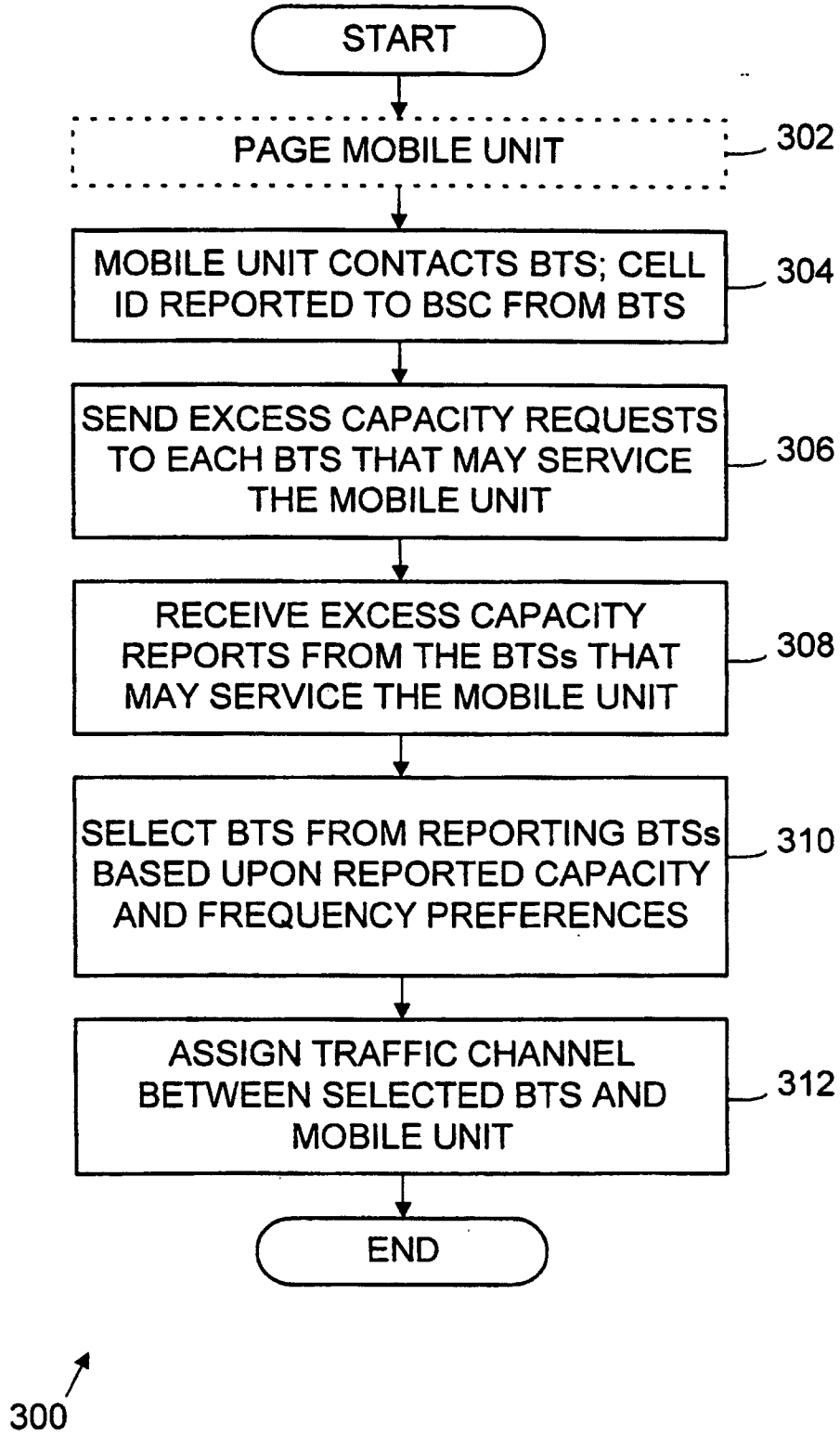
START
PAGE MOBILE UNIT
302
MOBILE UNIT CONTACTS BTS; CELL ID REPORTED TO BSC FROM BTS
304
SEND EXCESS CAPACITY REQUESTS TO EACH BTS THAT MAY SERVICE THE MOBILE UNIT
306
RECEIVE EXCESS CAPACITY REPORTS FROM THE BTSs THAT MAY SERVICE THE MOBILE UNIT
308
SELECT BTS FROM REPORTING BTSs BASED UPON REPORTED CAPACITY AND FREQUENCY PREFERENCES
310
ASSIGN TRAFFIC CHANNEL BETWEEN SELECTED BTS AND MOBILE UNIT
312
END
300

FIG. 3

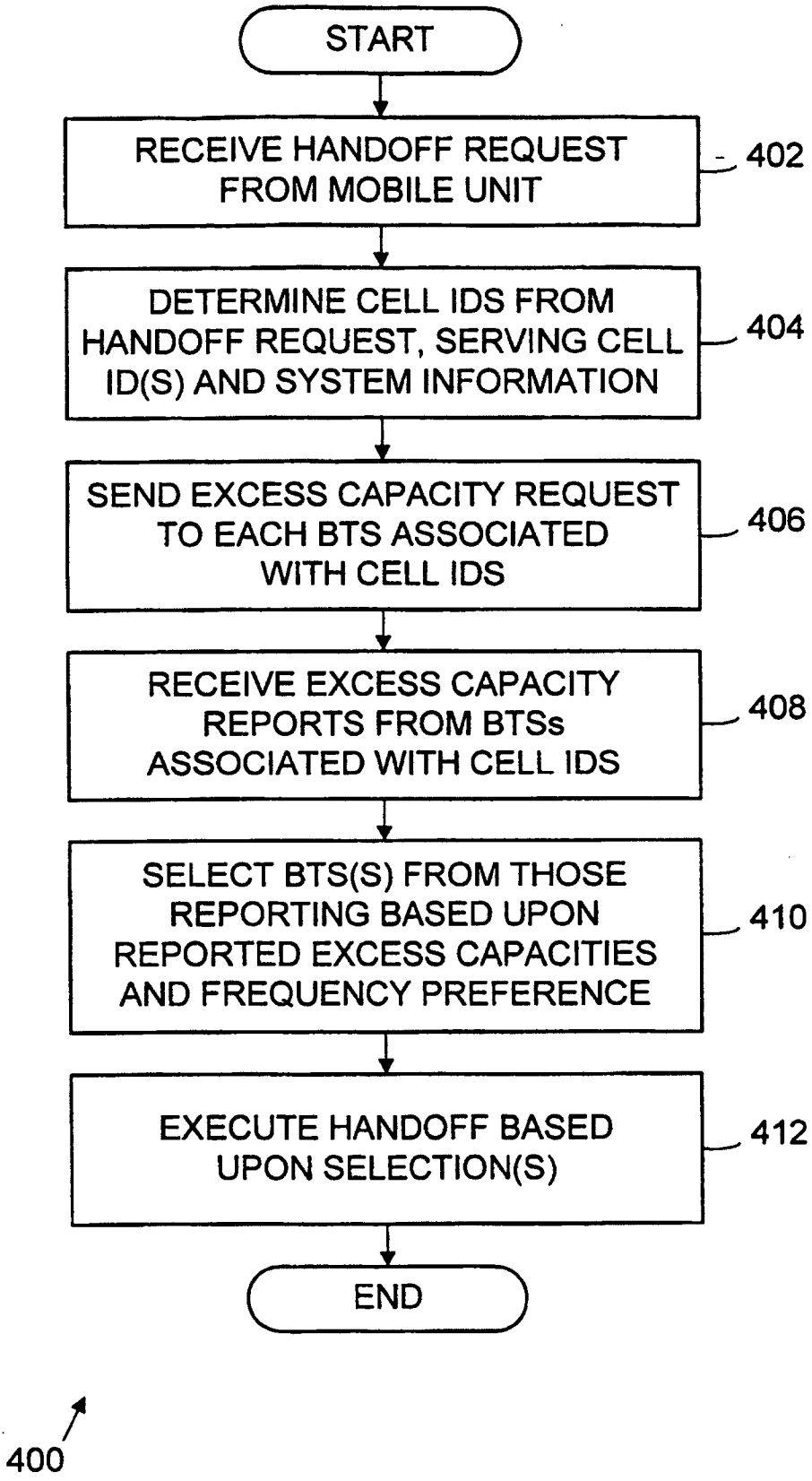
START
RECEIVE HANDOFF REQUEST FROM MOBILE UNIT
402
DETERMINE CELL IDS FROM HANDOFF REQUEST, SERVING CELL ID(S) AND SYSTEM INFORMATION
404
SEND EXCESS CAPACITY REQUEST TO EACH BTS ASSOCIATED WITH CELL IDS
406
RECEIVE EXCESS CAPACITY REPORTS FROM BTSs ASSOCIATED WITH CELL IDS
408
SELECT BTS(S) FROM THOSE REPORTING BASED UPON REPORTED EXCESS CAPACITIES AND FREQUENCY PREFERENCE
410
EXECUTE HANDOFF BASED UPON SELECTION(S)
412
END
400

FIG. 4

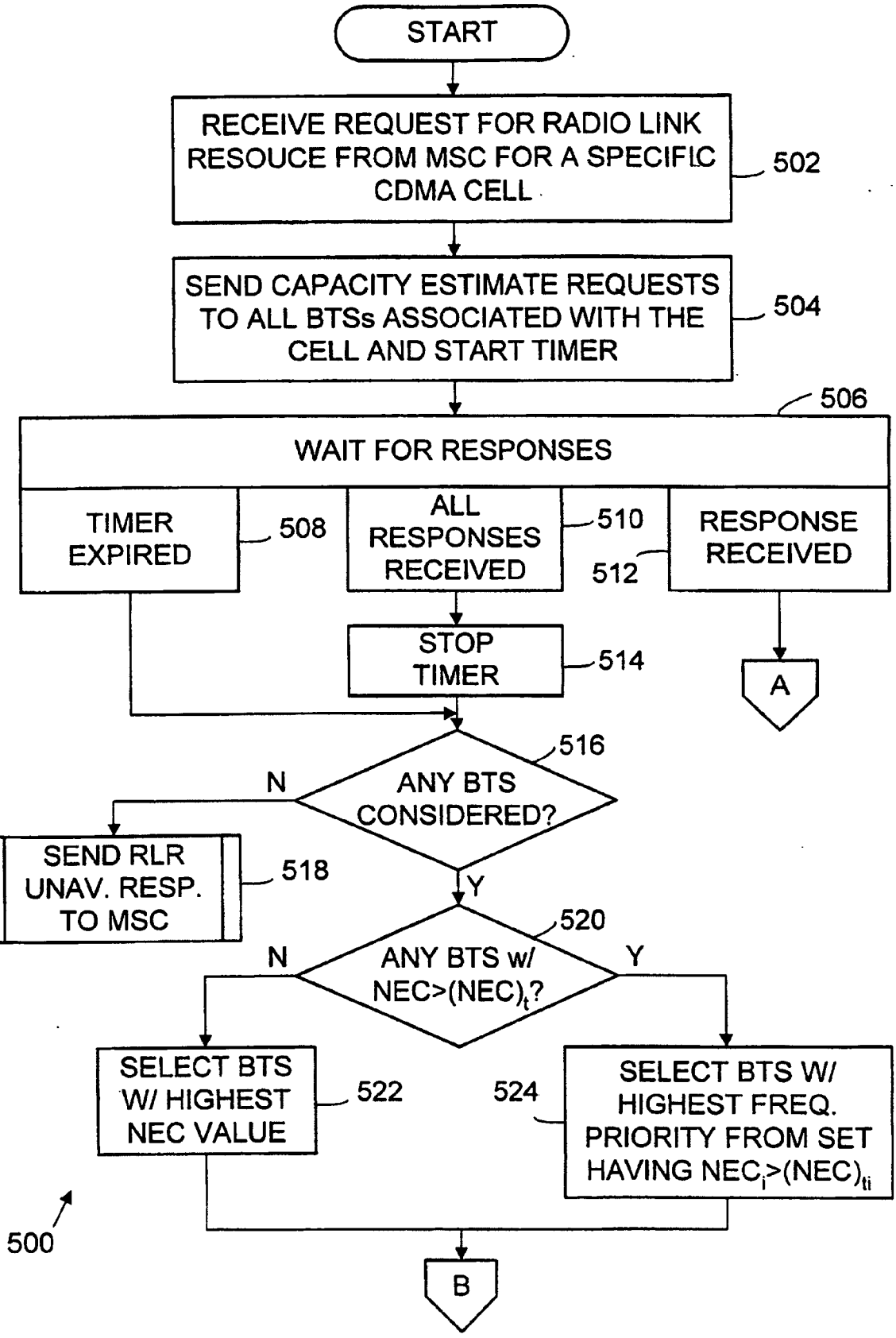
START
RECEIVE REQUEST FOR RADIO LINK RESOUCE FROM MSC FOR A SPECIFIC CDMA CELL
502
SEND CAPACITY ESTIMATE REQUESTS TO ALL BTSs ASSOCIATED WITH THE CELL AND START TIMER
504
506
WAIT FOR RESPONSES
TIMER EXPIRED
508
ALL RESPONSES RECEIVED
510
RESPONSE RECEIVED
512
STOP TIMER
514
A
516
N
ANY BTS CONSIDERED?
SEND RLR UNAV. RESP. TO MSC
518
Y
520
N
ANY BTS w/ NEC>(NEC)t?
Y
SELECT BTS W/ HIGHEST NEC VALUE
522
524
SELECT BTS W/ HIGHEST FREQ. PRIORITY FROM SET HAVING NECi>(NEC)ti
500
B

FIG. 5A

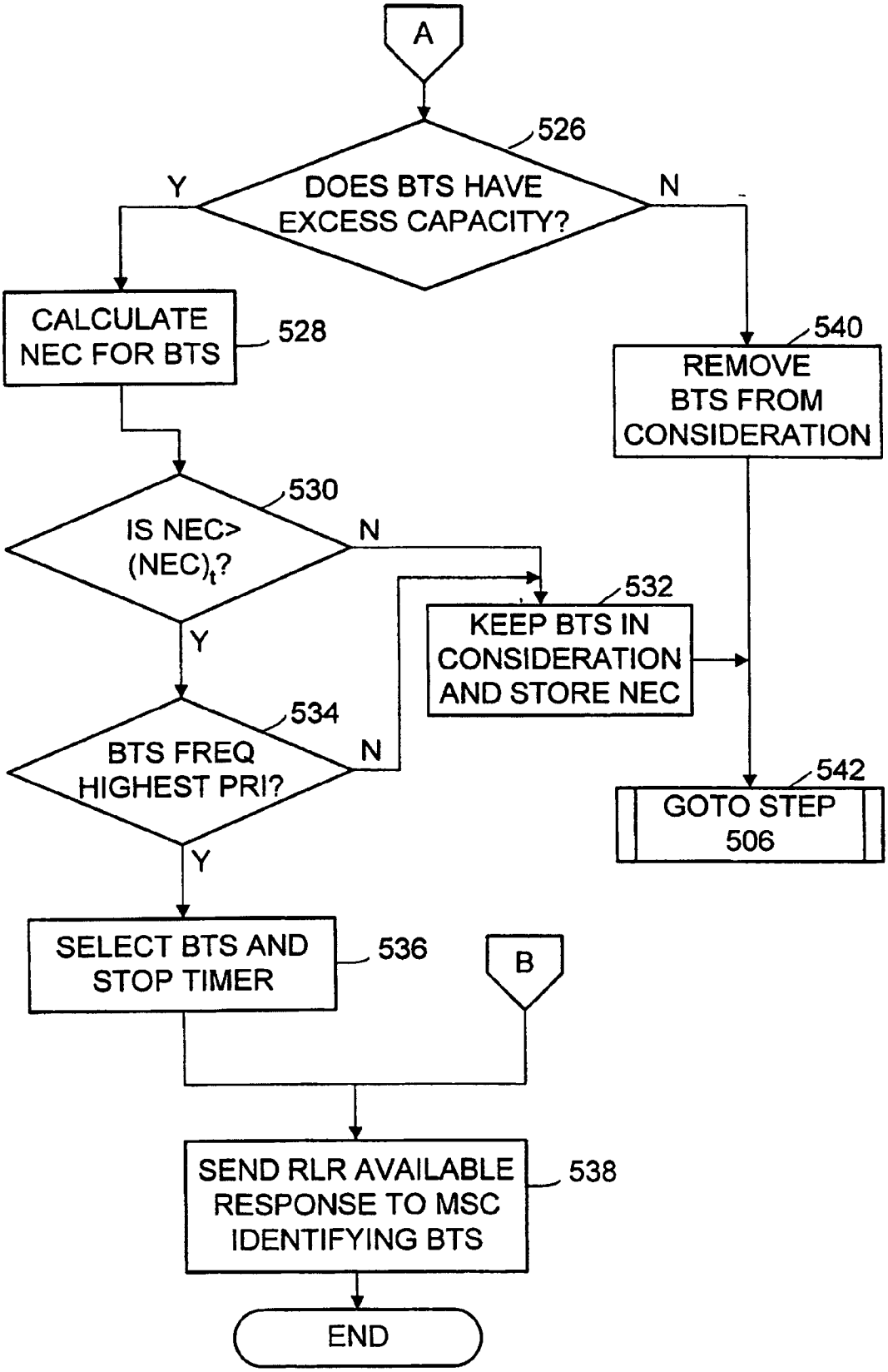
A
526
DOES BTS HAVE EXCESS CAPACITY?
Y
N
CALCULATE NEC FOR BTS
528
540
REMOVE BTS FROM CONSIDERATION
530
IS NEC> (NEC)t?
N
Y
532
KEEP BTS IN CONSIDERATION AND STORE NEC
534
BTS FREQ HIGHEST PRI?
N
Y
542
GOTO STEP 506
SELECT BTS AND STOP TIMER
536
B
SEND RLR AVAILABLE RESPONSE TO MSC IDENTIFYING BTS
538
END

FIG. 5B

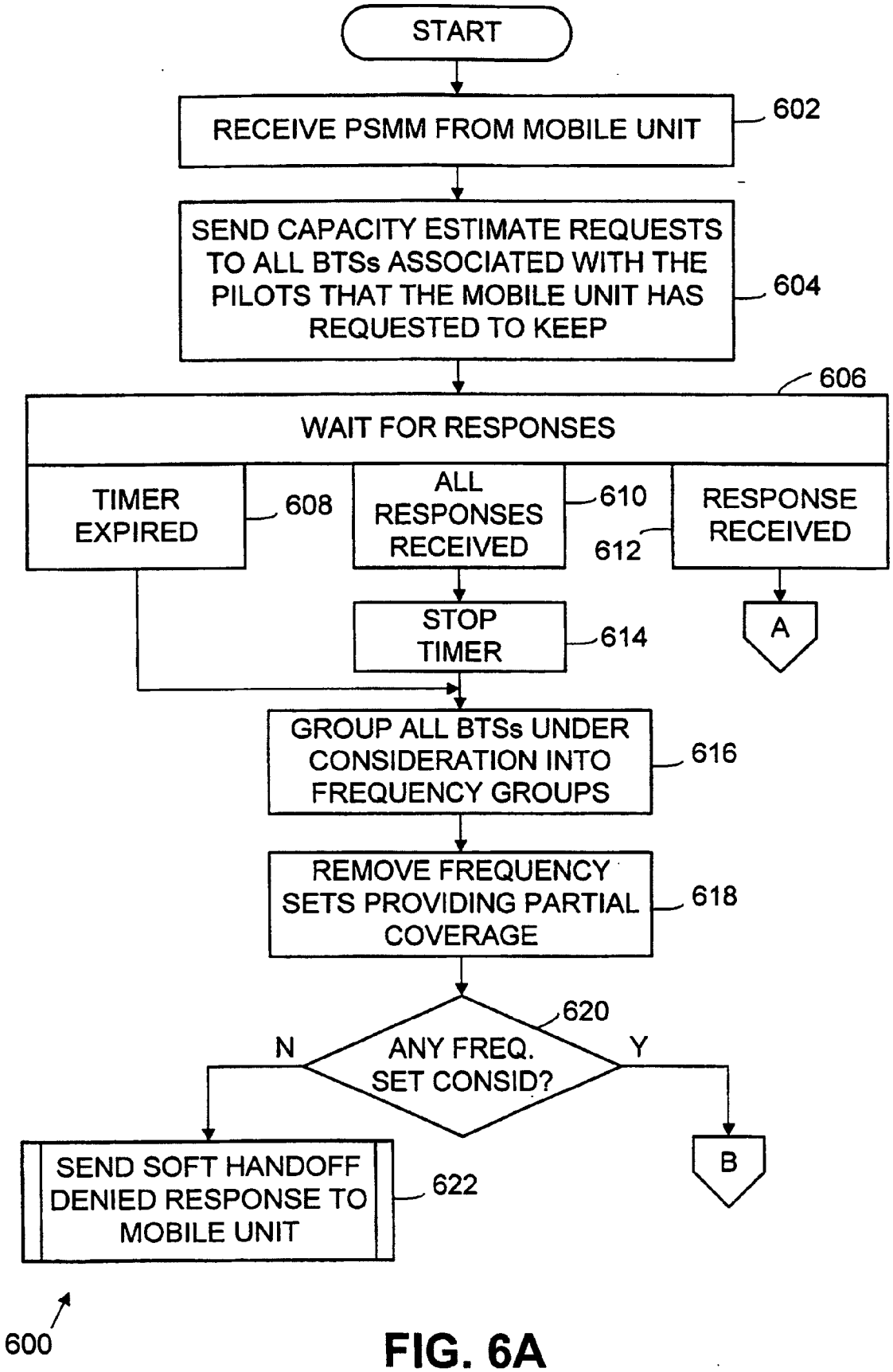
START
RECEIVE PSMM FROM MOBILE UNIT
602
SEND CAPACITY ESTIMATE REQUESTS TO ALL BTSs ASSOCIATED WITH THE PILOTS THAT THE MOBILE UNIT HAS REQUESTED TO KEEP
604
606
WAIT FOR RESPONSES
TIMER EXPIRED
608
ALL RESPONSES RECEIVED
610
RESPONSE RECEIVED
612
STOP TIMER
614
A
GROUP ALL BTSs UNDER CONSIDERATION INTO FREQUENCY GROUPS
616
REMOVE FREQUENCY SETS PROVIDING PARTIAL COVERAGE
618
620
N
ANY FREQ. SET CONSID?
Y
B
SEND SOFT HANDOFF DENIED RESPONSE TO MOBILE UNIT
622
600

FIG. 6A

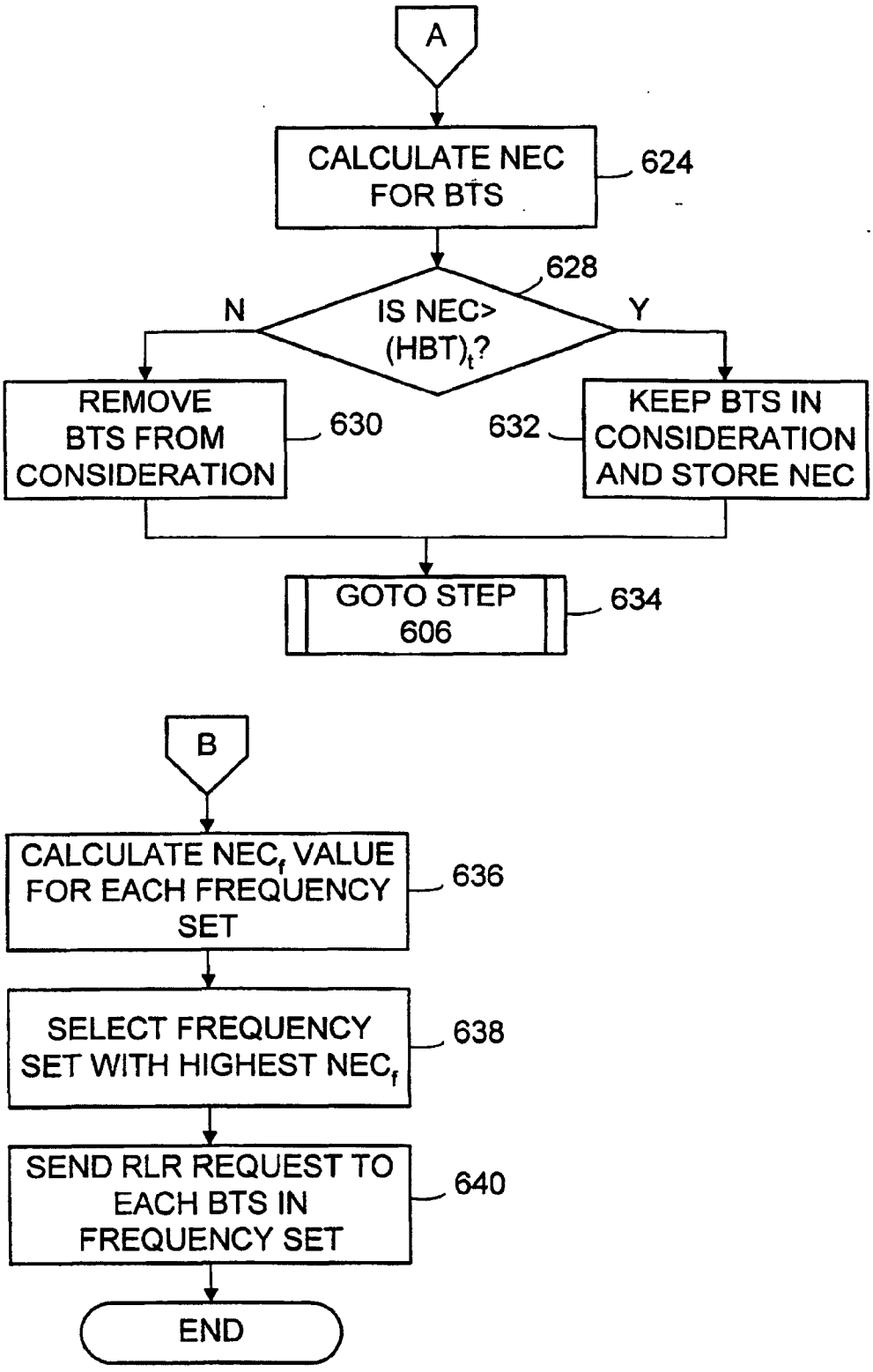
A
CALCULATE NEC FOR BTS
624
628
IS NEC> (HBT)t?
N
Y
REMOVE BTS FROM CONSIDERATION
630
632
KEEP BTS IN CONSIDERATION AND STORE NEC
GOTO STEP 606
634
B
CALCULATE NECf VALUE FOR EACH FREQUENCY SET
636
SELECT FREQUENCY SET WITH HIGHEST NECf
638
SEND RLR REQUEST TO EACH BTS IN FREQUENCY SET
640
END

FIG. 6B

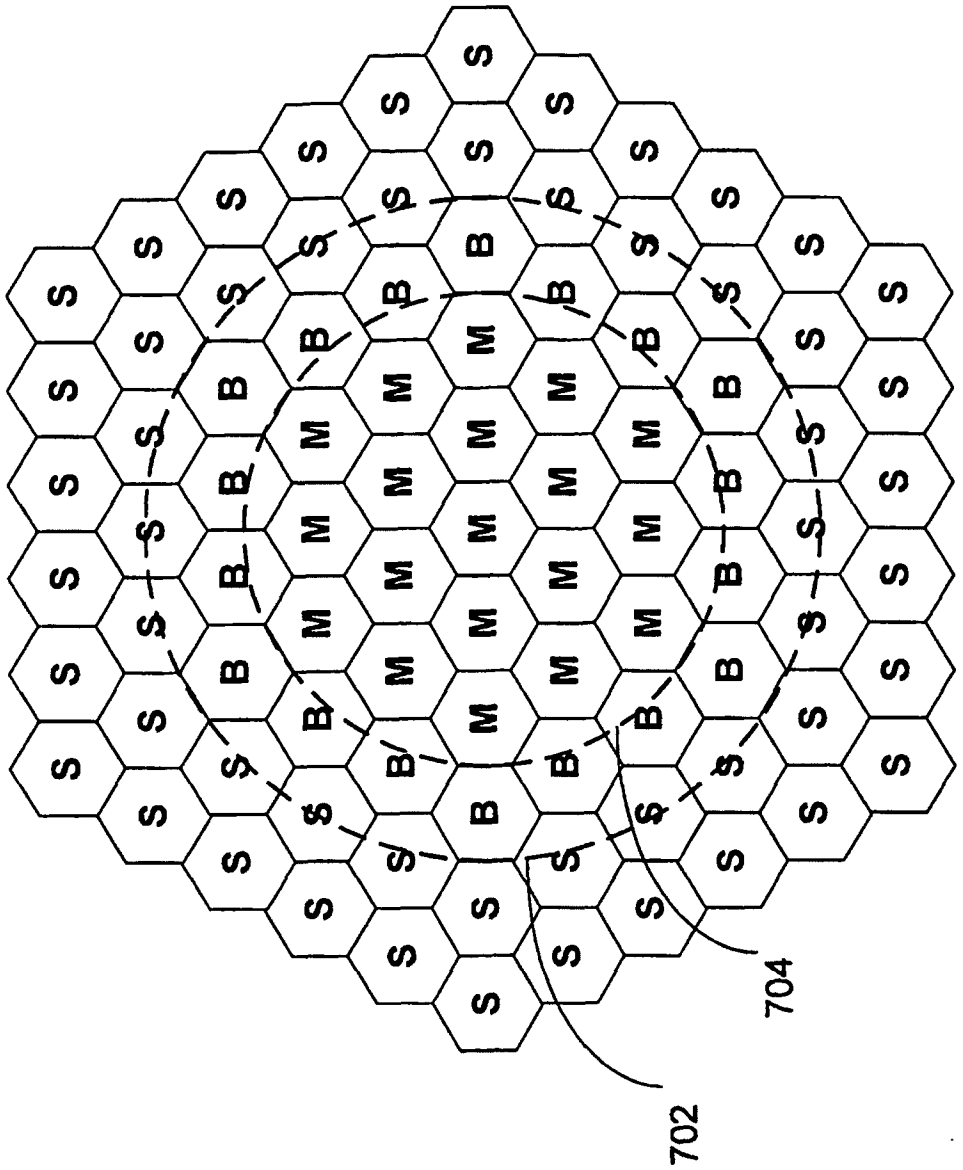
700
702
704
M = MULTIPLE CARRIER CELLS
B = BORDER CELLS
S = SINGLE FREQUENCY CELLS

FIG. 7

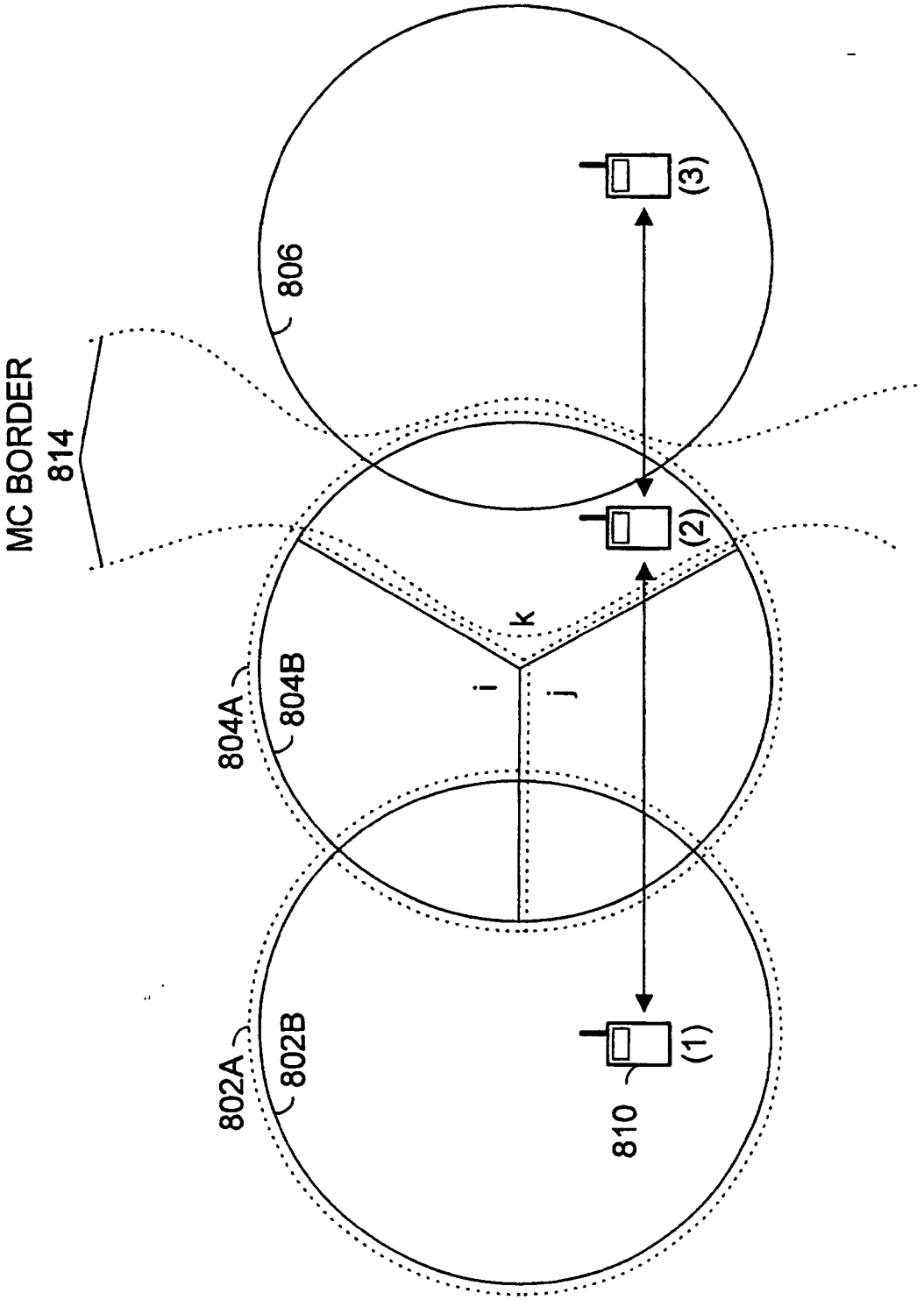

FIG. 8

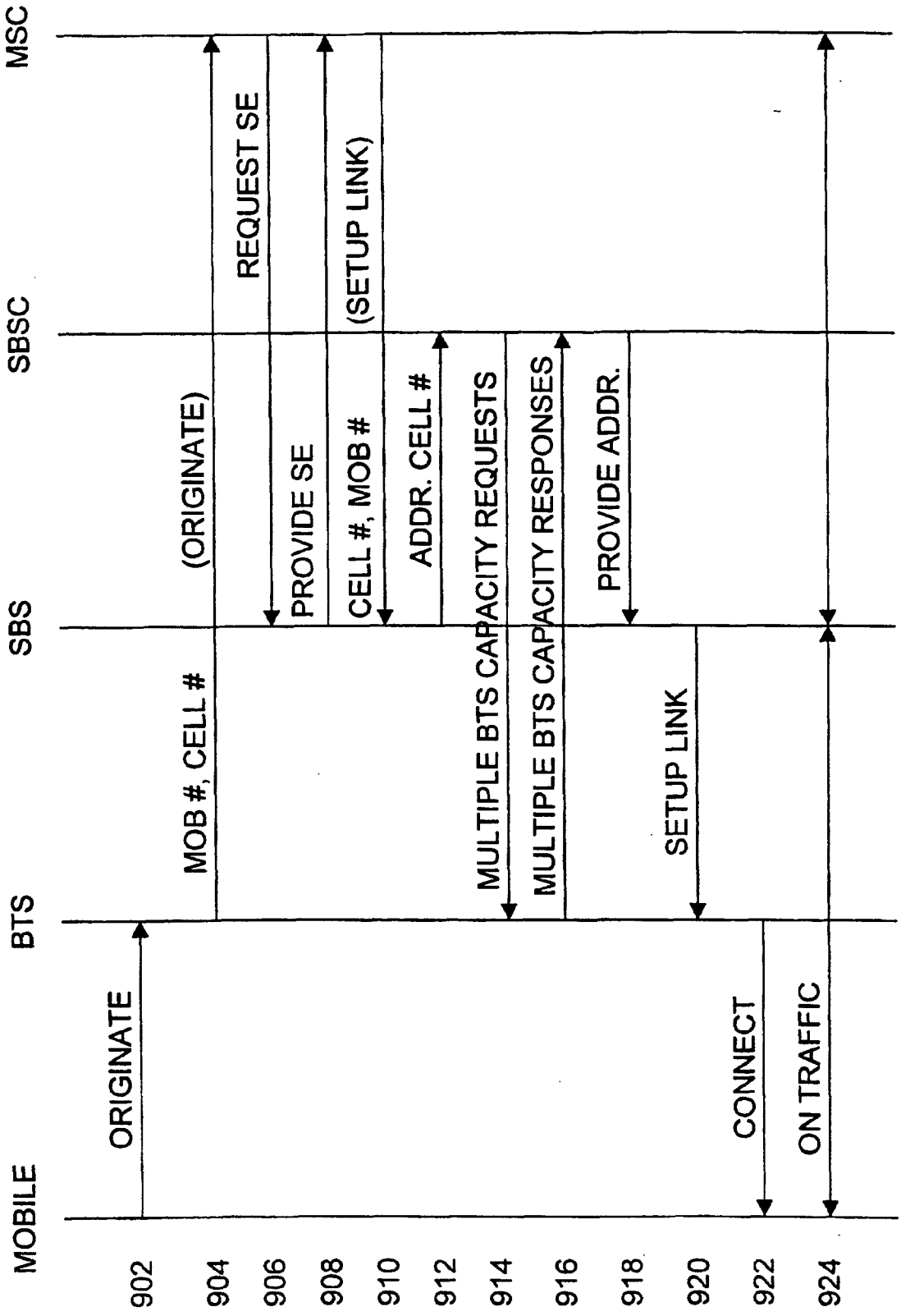
MOBILE
BTS
SBS
SBSC
MSC
ORIGINATE
MOB #, CELL #
(ORIGINATE)
REQUEST SE
PROVIDE SE
CELL #, MOB #
(SETUP LINK)
ADDR. CELL #
MULTIPLE BTS CAPACITY REQUESTS
MULTIPLE BTS CAPACITY RESPONSES
PROVIDE ADDR.
SETUP LINK
CONNECT
ON TRAFFIC
902
904
906
908
910
912
914
916
918
920
922
924

FIG. 9

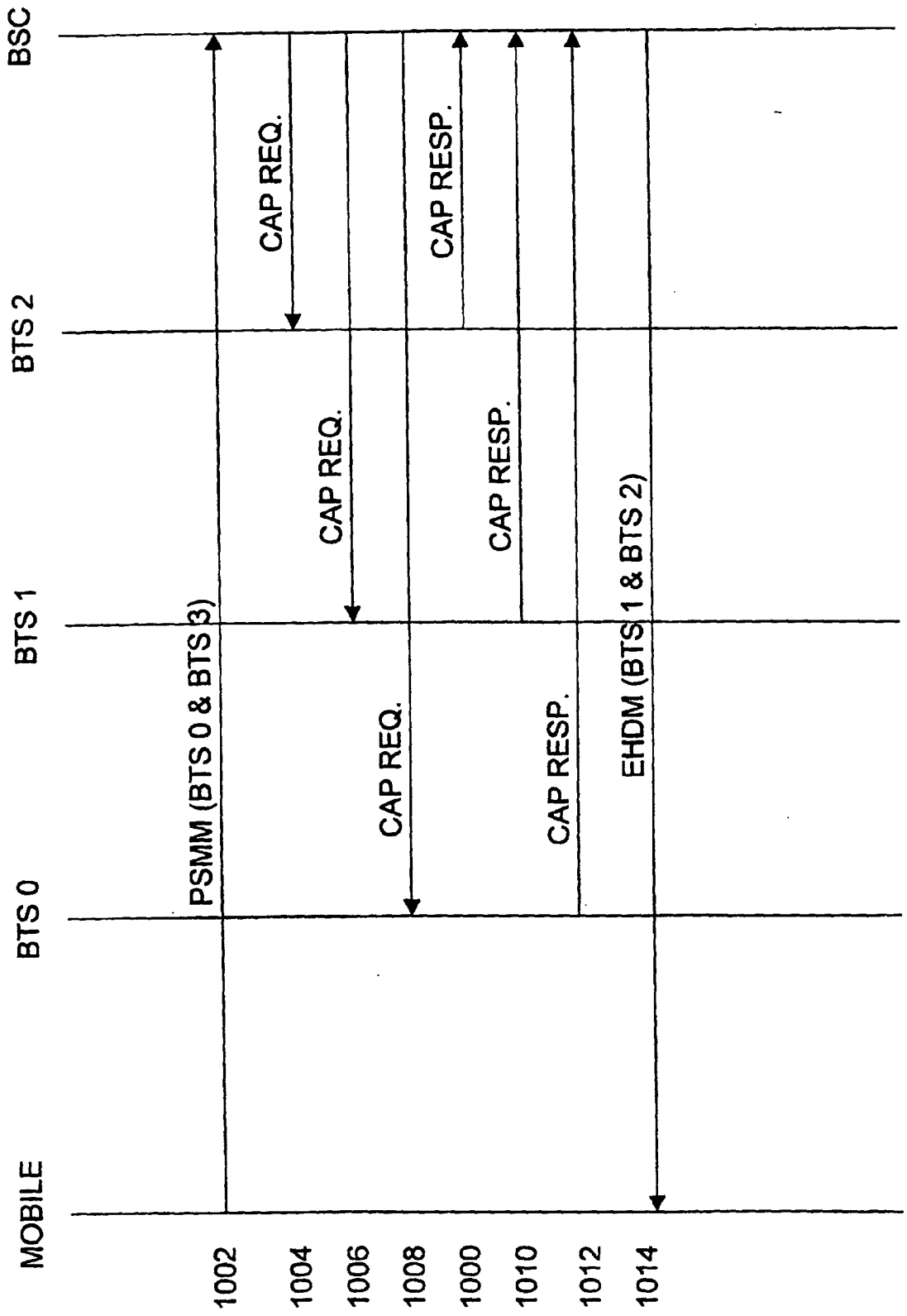
BSC
BTS 2
BTS 1
BTS 0
MOBILE
CAP REQ.
CAP RESP.
CAP REQ.
CAP RESP.
CAP REQ.
CAP RESP.
PSMM (BTS 0 & BTS 3)
EHDM (BTS 1 & BTS 2)
1002
1004
1006
1008
1000
1010
1012
1014

FIG. 10